Arke SO_3 System

Instruction Manual

Part Number 111752-00
12Apr2013

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About This Manual

This manual provides information about installing, operating, maintaining, and servicing the Arke SO_3 System. It also contains important alerts to ensure safe operation and prevent equipment damage. The manual is organized into the following chapters and appendixes to provide direct access to specific operation and service information.

- Chapter 1 "Introduction" provides an overview of the product, describes the system configuration and the operating principle of the system.
- Chapter 2 "Installation" describes how to install and start up the system. This will include how to install the probe and umbilical plumbing hookup.
- Chapter 3 "User Interface" provides information on how to use the touch screen display. Each menu and submenu is explained.
- Chapter 4 "Calibration" provides an overview on the equipment needed for calibrations and a description on how to calibrate the system.
- Chapter 5 "Preventive Maintenance and Servicing" describes the periodic maintenance procedures that should be performed on the system instruments and components to ensure proper operation.
- Chapter 6 "Troubleshooting" provides details and guidance on how to determine and solve common problems.
- Chapter 7 "System Component Description" provides an overview and describes the function of the system components.
- Appendix A "Warranty" is a copy of the warranty statement.
- Appendix B "ePort PC Software".provides a description on how to install and use the ePort PC software.
- Appendix C "Serial Communication" provides information on the AK protocol procedure.
- Appendix D "Error Code Troubleshooting" provides a list of error codes for the instrument.

Safety

Review the following information carefully before using the system. This manual provides specific information on how to operate the system, however, if the system is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety and Equipment Damage Alerts

This manual contains important information to alert you to potential safety hazards and risks of equipment damage. Refer to the following types of alerts you may see in this manual.

Safety and Equipment Damage Alert Descriptions

Alert		Description
	DANGER	A hazard is present that will result in death or serious personal injury if the warning is ignored. ▲
	WARNING	A hazard is present or an unsafe practice can result in serious personal injury if the warning is ignored. ▲
	CAUTION	The hazard or unsafe practice could result in minor to moderate personal injury if the warning is ignored. ▲
	Equipment Damage	The hazard or unsafe practice could result in property damage if the warning is ignored. ▲

Safety and Equipment Damage Alerts in this Manual

Alert		Description
	DANGER	Use caution when removing a panel, especially if it has the potential to free fall or be blown by the wind. ▲
	WARNING	Adjusting the detector controls by a non-qualified individual can result in damages to the detector. ▲
		The service procedures in this manual are restricted to qualified service personnel only. ▲
		If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲
		Adjusting the detector controls and laser controls by a non-qualified individual can result in damages to the detector and laser. ▲
		Do not exceed 0.3 V. ▲

Alert		Description
		Do not exceed 2.5 V. ▲
	Equipment Damage	Do not attempt to lift the instrument by the cover, air conditioner, or other external fittings. ▲ There is a bulkhead fitting used as an atmospheric dump on the bottom of the enclosure. Take care not to damage. ▲ If the bench heater is ON, ensure that the instrument door is either open or that the Air Conditioning unit is ON. If the bench heater is ON with the door closed and the Air Conditioning OFF, thermal damage to the boards may occur. ▲ Adjusting the laser control by a non-qualified individual can result in damages to the laser and laser housing. ▲

WEEE Symbol

The following symbol and description identify the WEEE marking used on the instrument and in the associated documentation.

Symbol	Description
	Marking of electrical and electronic equipment which applies to electrical and electronic equipment falling under the Directive 2002/96/EC (WEEE) and the equipment that has been put on the market after 13 August 2005. ▲

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Chapter 1
Introduction

The Arke SO_3 System is designed to measure SO_3 from combustion gas streams. The measurement location can be anywhere from the air heater inlet through to the stack. The system is comprised of three major components; 9800 QC Laser-Based SO_3 Analyzer, PRO9805 Dilution Extractive Probe, and Air Handling System. There are also three support lines that connect these measurement modules, as shown in Figure 1–1. All the monitoring components are designed to be located outside of a shelter.

For details of the instrument's theory of operation and product specifications, see the following topics:

- "SO3 Analyzer Theory of Operation" on page 1-3
- "PRO9805 Dilution Extractive Probe" on page 1-4
- "Specifications" on page 1-8

Thermo Fisher Scientific is pleased to supply this Arke SO_3 System. We are committed to the manufacture of instruments exhibiting high standards of quality, performance, and workmanship. Service personnel are available for assistance with any questions or problems that may arise in the use of this system. For more information on servicing, see the "Preventive Maintenance and Servicing" chapter starting on page 5-1.

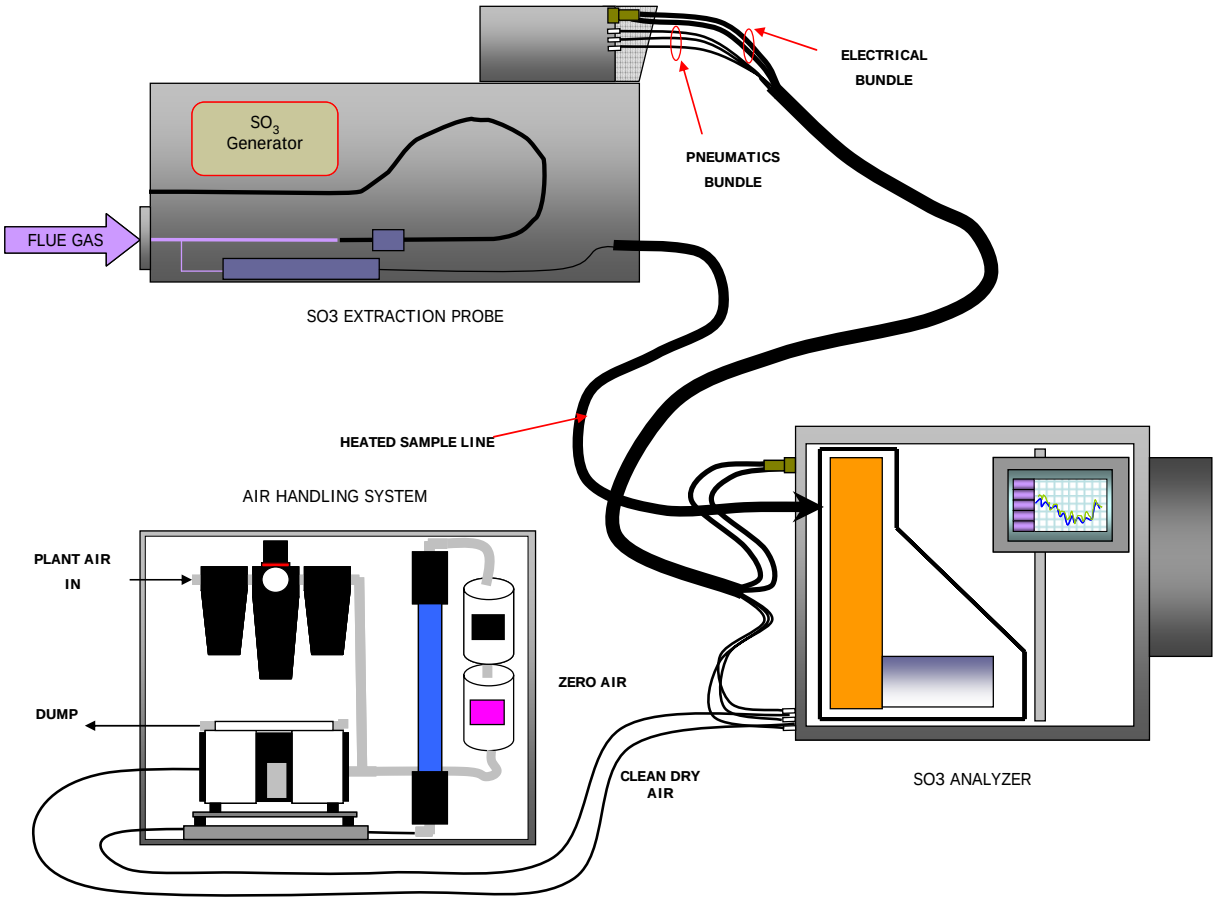


Figure 1–1. Arke SO_3 System Configuration

SO_3 Analyzer Theory of Operation

The Arke SO_3 System is designed to measure SO_3 from a combustion source or an industrial process. It extracts, dilutes and transports the sample at an elevated temperature in order to keep the SO_3 from reacting with water, as well as convert any extracted H_2SO_4 into SO_3.

The measurement of SO_3 is done by molecular absorbance. A Quantum Cascade (QC) laser emits pulses of mid infrared light through a heated optical cell. The light emitted by the QC laser is at a frequency at which SO_3 molecules absorb light. Like most gases, SO_3 absorbs light to various degrees at multiple wavelengths. The QC laser is tuned to an area of the spectrum where SO_3 strongly absorbs, while other gases which are common in combustion process such as SO_2, water, and CO_2 do not. This greatly minimizes any measurement interferences from these other gases.

The optical cell has a special coating and is heated to 220 °C in order to minimize reaction of SO_3 with the walls and other gases. The cell measures 0.4 meters long but has an effective pathlength of 12.8 meters due to high temperature mirrors within. The light exiting the cell excites a thermo electrically cooled MCT detector. The absorption of light at certain wavelengths is proportional to the concentration of SO_3 within the optical cell. Figure 1–2 shows an absorption spectrum of SO_3 compared to the reference spectrum.

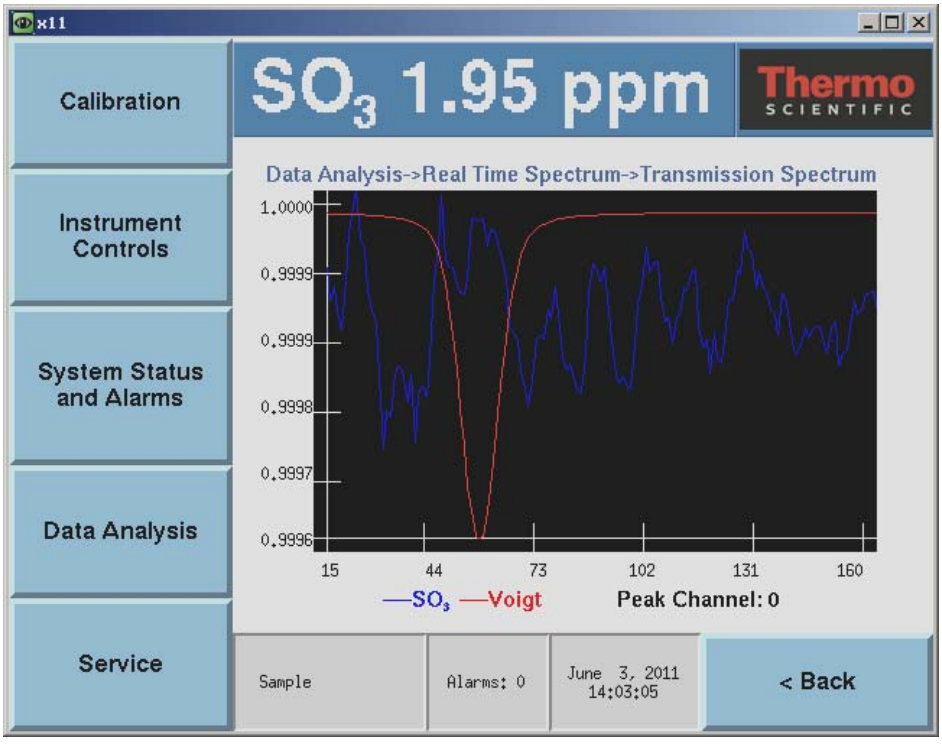


Figure 1–2. SO_3 Transmission Spectrum and Incoming Spectrum

PRO9805 Dilution Extractive Probe

The PRO9805 Dilution Extractive Probe is configured as one component of Thermo Scientific's Arke SO_3 System. The probe with its built-in diluting assembly has been designed specifically to monitor SO_3 at various locations within a coal-fired power plant.

The PRO9800 Probe is constructed of a 316 stainless steel enclosure. To prevent sample condensation, all key elements (Inertial Filter, Diluting Probe and Sample Eductor) have been mounted between heated aluminum blocks that can be maintained at temperatures as high as 300 °C.

The enclosure also houses an accumulator tank for back purging of the inertial filter tube (blow back). External to the enclosure is a section with the electrical connections, solenoids for filter and stinger blow back, cal gas, zero gas, and a differential pressure transducer.

A special 4-inch adapted mounting flange has been supplied for installation onto the port of the stack or duct.

Clean dry pressurized (80 psig) air feeds two electronic pressure regulators within the 9800 SO_3 Analyzer, which adjust and maintain output pressure to the PRO9805 Probe eductor and dilution module (Figure 1–3). Also contained within the 9800 SO_3 Analyzer are three electronic pressure transducers associated with the individual regulators, as well as an electronic vacuum transducer monitoring the dilution module vacuum in the PRO9805 Probe.

The PRO9805 Probe includes an inertial filter with a built in dilution module which prepares the sample for subsequent analysis by the 9800 SO_3 Analyzer.

The 9800 SO_3 Analyzer provides 220 AC voltage to the PRO9805 Probe, which powers the probe block heaters, SO3 generator heater, stinger heater, four probe solenoid valves for cal/zero gas, stinger blow back, and filter blow back. The 9800 SO_3 Analyzer also receives a 4-20 ma signal from the fast loop venturi pressure transducer.

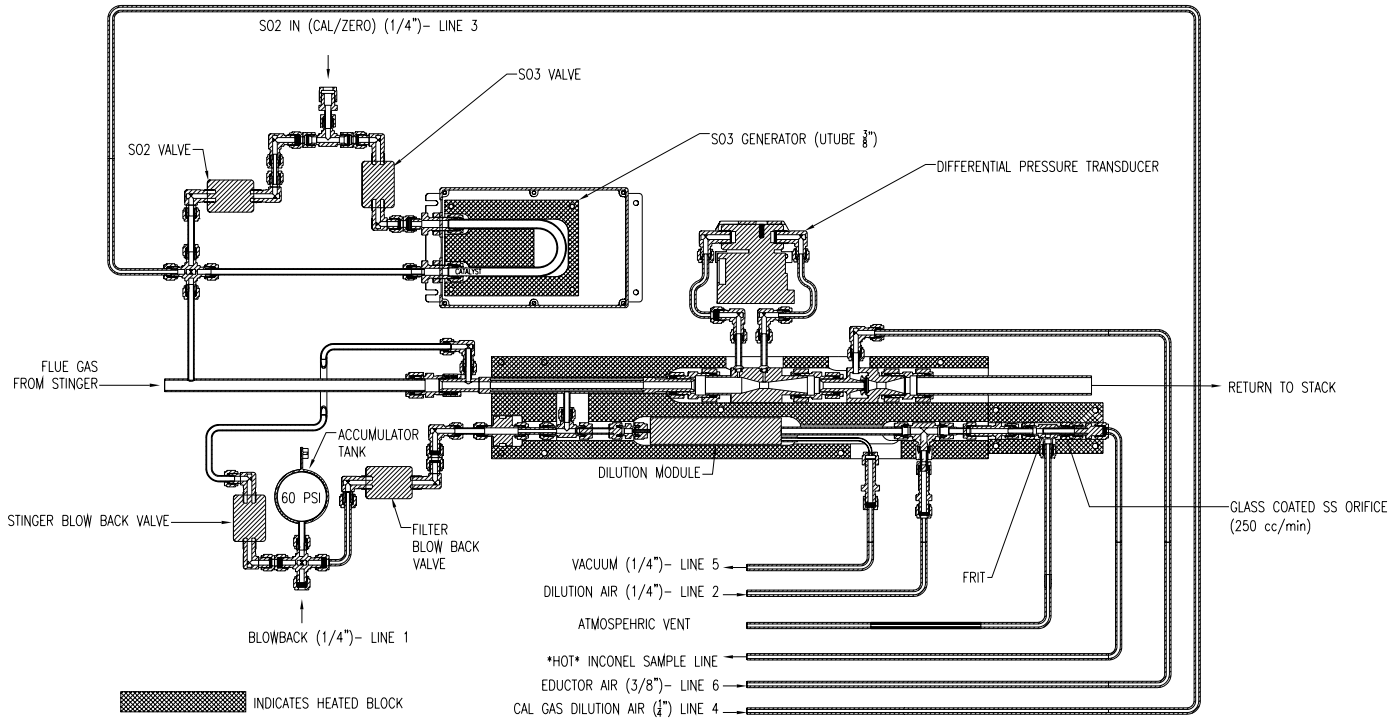


Figure 1–3. PRO9805 Dilution Extractive Probe Plumbing

The SO_3 generator serves to calibrate the system with a known amount of SO_3. The generator is located in the probe and the SO_3 calibration gas follows the same path as the sample gas. The calibration gas will pass through the probe assemblies and hotline before reaching the measurement bench. Since the calibration gas passes along the same path as sample gas, it will yield a reliable calibration relative to sample readings.

Construction of the Inertial Filter

The inertial filter is a filter assembly with a porous filter element that can be cleaned in situ by simple high pressure blow back. This filter element is a silica coated 316L stainless steel 10-inch long diffusion-bonded, sintered seamless porous tube with a 0.5 micron grade.

A filter housing tube surrounds the tubular element, creating a minimum-volume annular plenum for sample collection. A high-efficiency gas eductor induces axial flow through the filter element.

Operating Principle of the Inertial Filter Tube

A high-velocity gas flow (70 to 100 fps) will develop axially through the porous filter tube. From this mainstream flow, a clean sample flow will develop radially through the porous tube wall at a very low face velocity (0.005 fps), passing into the housing annulus and out the sample tube.

The ballistic effect of particle inertia will prevent particles entrained in the high-velocity axial gas flow from depositing on or penetrating the porous filter wall. The low radial velocity also inhibits particles from penetrating the porous wall.

Superfine particles that do enter the porous media form a permeable surface cake or "dynamic membrane" of approximately 0.010-inch deep. This membrane then becomes the effective filter medium, and it bars the passage of contaminants much smaller than the filter pore size. Scouring or abrasive damage to the porous wall is prevented by the presence of a thin zero-velocity Prandtl boundary layer.

While the filter is on-stream, sample flow continues without interruption so representative samples are constantly furnished. The housing annulus has a very low volume, to minimize sample dwell time and ensure fresh samples.

Operating Principle of the SO_3 Generator

The SO_3 generator uses a patented process by which SO_2 (sulfur dioxide) gas is heated and reacted into SO_3 (sulfur trioxide) gas (Figure 1–4). This reaction is done a short distance from the probe injection point to help minimize contact of SO_3 with cold spots. SO_3 will adsorb to any "cool" surface (below 220 °C). The SO_2 gas is originated from a standard SO_2 in air cylinder. If operated and maintained correctly, the generating efficiency of SO_2 into SO_3 is >97%. An SO_2 source with a nitrogen balance will **not** produce SO_3.

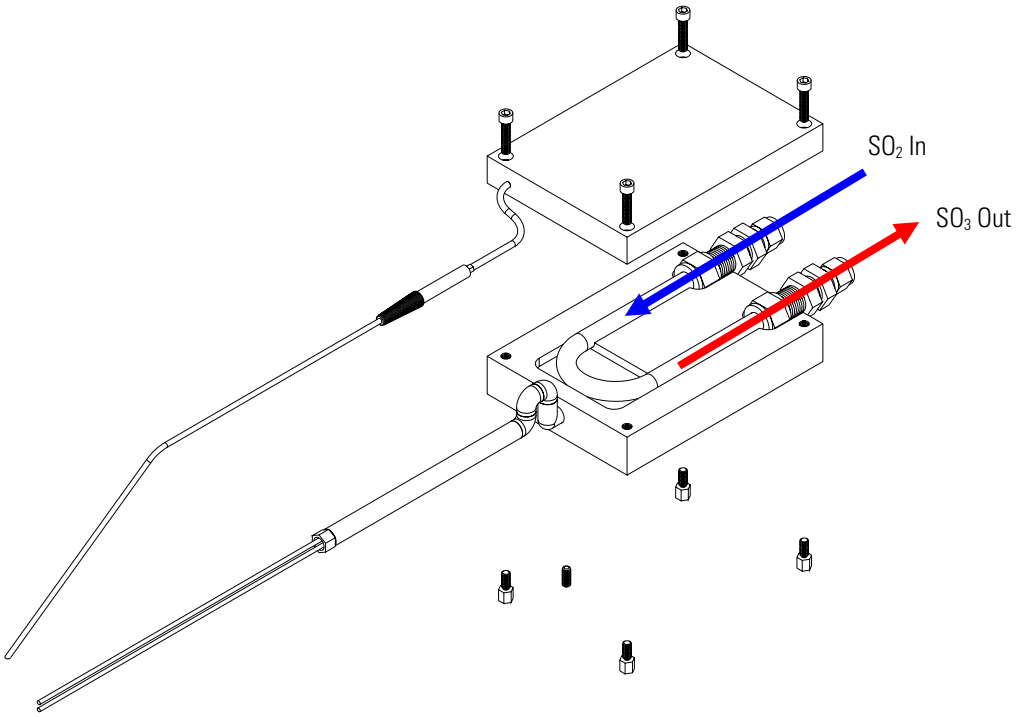


Figure 1–4. U-Tube Flow Diagram

Calibration Method

The Arke SO_3 System is calibrated by introducing the span gas at the stinger. In this way both the span gas and sample gas will follow the same path through the system. This will produce a more reliable calibration. If there are losses in the sample gas, there will be similar losses during calibration.

SO_2 Cylinder

The SO_2 cylinder should have a concentration between 1000 and 1200 ppm, depending on the desired SO_3 range, and be in a balance of air. The regulated output pressure should be between 30 and 40 psig. If the balance gas is N_2, it will not work.

Note Balance gas must be air. ▲

Specifications

Table 1–1 lists the specifications for the Arke SO_3 System.

Table 1–1. Arke SO_3 System Specifications

Range	0–200 ppm
Zero noise	0.2 ppm (300 second average)
Lower detectable limit	0.4 ppm (300 second average)
Zero drift (24 hour)	<0.5 ppm
Span drift	2% full scale
Linearity	1% full scale
Water Interference	1x10-5
SO_2 Interference	1x10-4
Sample flow rate	0.25 L/min
Operating temperature	-10 to 45 °C
Power requirements	208–250 VAC, 25 amps
Analyzer physical dimensions	30" (W) X 30" (H) X 12" (D) 145 lbs
Analog outputs	6 voltage outputs; 0–100 mV, 1V, 10 V (user selectable), 5% of full-scale over/under range (user selectable), 12 bit resolution, measurement output user selectable per channel
Analog inputs	4 analog inputs; user customizable
Digital outputs	4 digital outputs; 1 power fail relay Form C, 10 digital relays Form A, user selectable alarm output, relay logic, 100 mA @ 200 VDC
Digital inputs	8 digital inputs; user select programmable, TTL level, pulled high
Serial Ports	1 RS-232 or RS-485 with two connectors, baud rate 1200–115200, data bits, parity, and stop bits, protocols: C-Link, MODBUS, Gesytec (Bayern-Hessen), and streaming data (all user selectable)
Ethernet connection	RJ45 connector for 10Mbs Ethernet connection, static or dynamic TCP/IP addressing

Chapter 2
Installation

The following installation procedure for the Arke SO_3 System describes setup and installation, including turning on the instrument, enabling heaters, coolers, and the QC laser. The installation should always be followed by instrument calibration as described in the "Calibration" chapter of this manual. For details, see the following topics:

- "Instrument Installation" on page 2-1
- "Probe Installation" on page 2-4
- "Start up Procedure" on page 2-13
- "HVAC" on page 2-15
- "Temperature Control Board Verification" on page 2-15
- "Power Distribution" on page 2-16

Equipment Damage Do not attempt to lift the instrument by the cover, air conditioner, or other external fittings. ▲

Instrument Installation

Ensure that the instrument is connected to the zero air box using the support umbilical, noting all labels to ensure proper connection.

Connect the heated umbilical to both the probe and the instrument (connector side goes toward the instrument chassis). Feed the electrical connectors through the black strain relief before inserting the heated line. (It may be necessary to swage on the 1/4-inch ferrule to the end of the umbilical before feeding it through the strain relief.) Once the umbilical is fed through the strain relief, connect the 1/4-inch nut to the bench assembly fitting. Ensure that the heated umbilical is properly strain relieved on the outside of the instrument to prevent excessive strain on the bench assembly. Once the tube is seated and tightened, connect the umbilical thermocouple connectors into the proper plug per the thermocouple connections diagram (Table 2–1). Plug the umbilical power into the bulk head military connector.

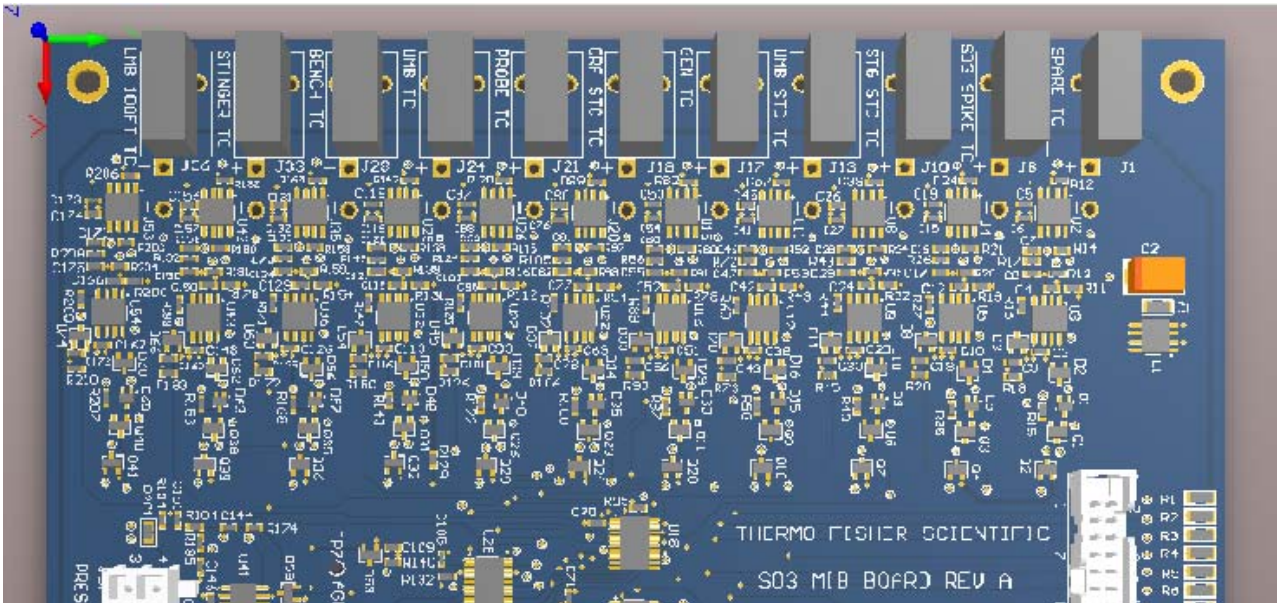


Figure 2–1. Thermocouple Connections

Connect the support umbilical from the probe to the instrument, noting all labels to ensure proper installation.

Terminate thermocouple ground lug to the nearest ground stud. For details, see Figure 2–2.

Ensure that compressed air is supplied to the Air handling box and that the Air handling box is powered up.

Table 2–1. Heater Location on Power Distribution Board and Temperature Setpoints

Thermocouple Location from the Front	Heater Description	Reading Degrees C
1	Spare	Not Used
2	Generator Stitch	300
3	Spare	Not Used
4	Umbilical Stitch	Not Used
5	Generator	425
6	Orifice Stitch	300
7	Probe	275
8	Umbilical	275
9	Bench	230
10	Stinger	350

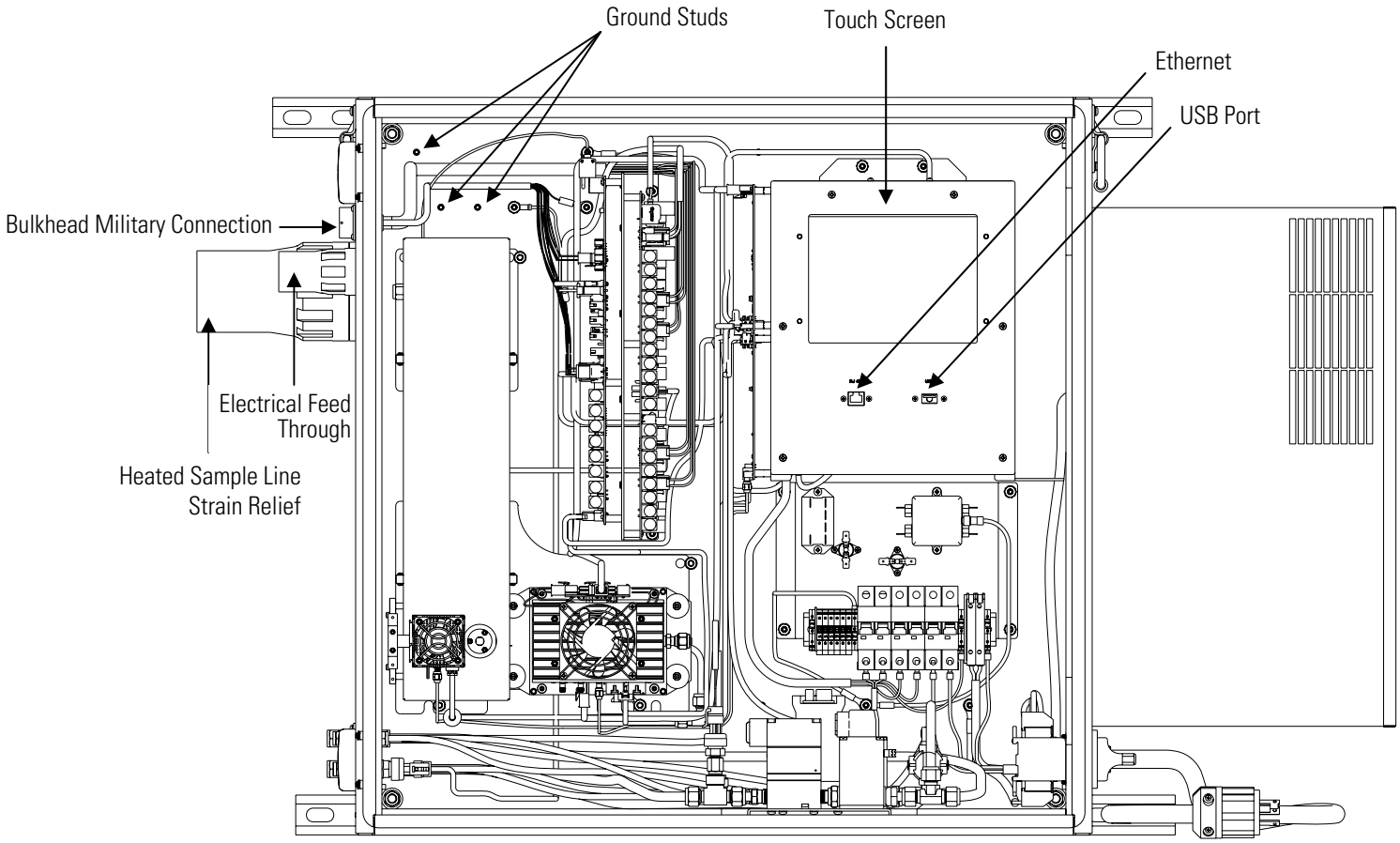


Figure 2–2. Component Layout

Probe Installation

The installation procedure of the PRO9805 Dilution Extractive Probe involves several steps:

- Preparing the Enclosure
- Stinger, Return Tube, and Stinger Heater Installation
- Stinger Clamps Installation
- Ash Deflector Installation
- Mounting the Mantle to Stack
- Umbilical Plumbing Hookup

Preparing the Enclosure

The PRO9805 Probe is supplied with a 3-inch Strain Relief Assembly to accommodate the Heated Umbilical Line (Figure 2–3). Some disassembly will be required to mount the enclosure to the process port. Both preparatory stages are described below.

The PRO9805 Probe allows for the Heated Line and associated strain relief, to be mounted either out of the rear or the bottom of the enclosure. This will allow each installation some flexibility in the sample line routing.

DANGER Use caution when removing a panel, especially if it has the potential to free fall or be blown by the wind. ▲

Equipment Damage Do not attempt to lift the instrument by the cover, air conditioner, or other external fittings. ▲

Equipment Damage There is a bulkhead fitting used as an atmospheric dump on the bottom of the enclosure. Take care not to damage. ▲

Remove the two (large) side panels from the enclosure, by rotating the compression latches counter clockwise. Both panels are identical. Maintain inward pressure on the center of the panel while unlatching to prevent panel from dropping (Figure 2–3).

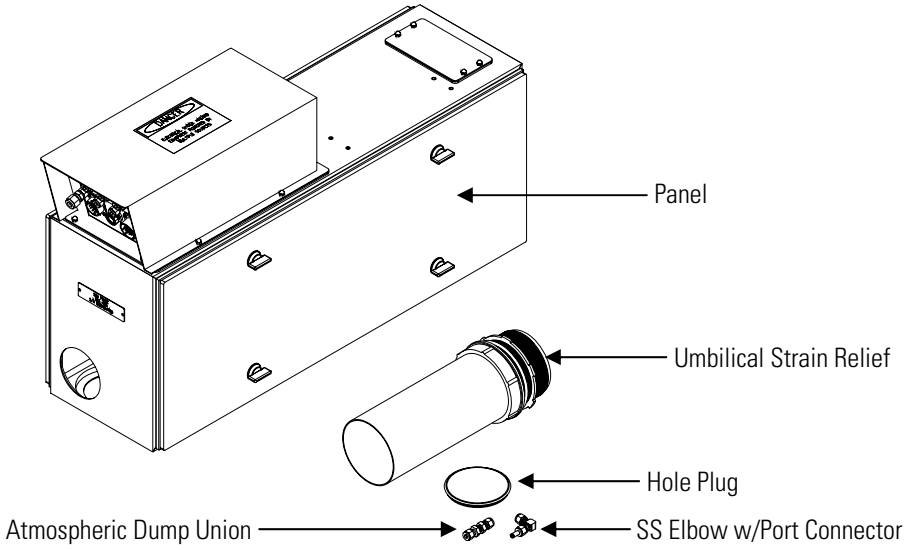


Figure 2–3. Umbilical Strain Relief and Atmospheric Dump Parts

Stinger, Return Tube, and Stinger Heater Installation

This procedure sets the sample and return tube in their optimum position.

1. Using a clockwise twisting motion, screw stinger heater onto tube until bottoming out in mantle (Figure 2–4).

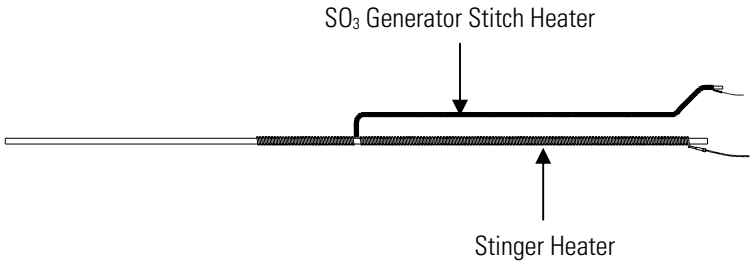


Figure 2–4. Stinger and SO_3 Generator Stitch Heater Installation

2. Loosen, but do not remove, the three nylon insert nuts that secure the fast loop assembly table to the enclosure and slide table all the way towards the front.

3. As in step 2 loosen (but do not remove) nylon insert nuts that secure the SO_3 generator assembly and slide the SO_3 generator assembly towards front.

4. Slide stinger and return tube through mantle from the mounting flange side approximately as shown. Just beyond the edge of the flange snug-fit tubing mantle fittings (for later adjusting).

5. On a bench or floor, taking care not to damage the atmospheric dump port (remove if necessary), line the mantle up with probe enclosure (Figure 2–5) with 3/4-inch fitting in 12 o'clock position.

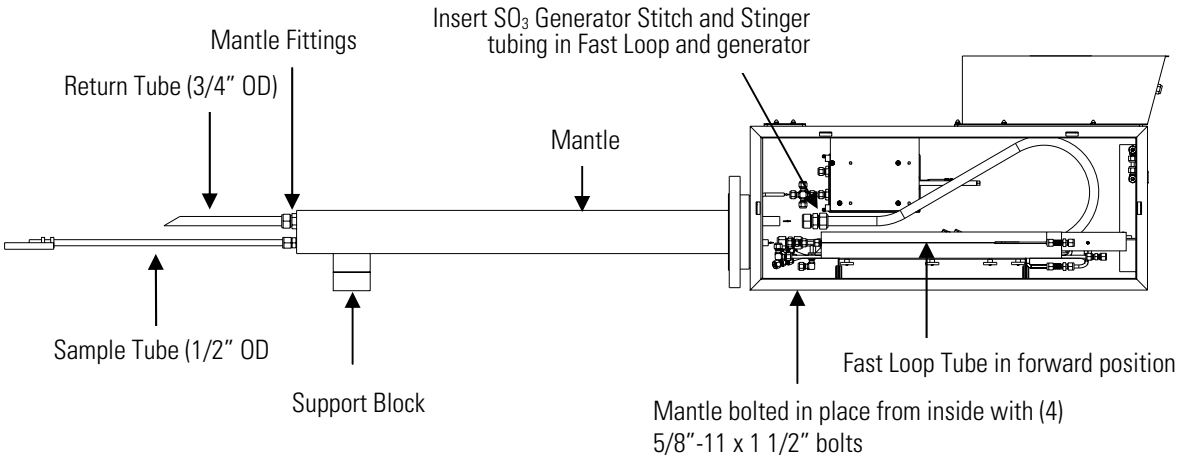

Insert SO_3 Generator Stitch and Stinger tubing in Fast Loop and generator
Mantle Fittings
Return Tube (3/4" OD)
Mantle
Sample Tube (1/2" OD
Support Block
Fast Loop Tube in forward position
Mantle bolted in place from inside with (4) 5/8"-11 x 1 1/2" bolts

Figure 2–5. Stinger, Spike, and Return Tube Adjustment

6. Bolt mantle in place with four 5/8-inch-11 x 1 1/2-inch bolts and split lock washers.

7. Fully insert stinger and SO_3 generator stitch tubing into their unions and tighten fittings. The spike tube (1/4-inch) is welded to the stinger tube on one side and unites with the generator output on the other side. The stinger tube unites with the fast loop sample (1/2-inch) in union.

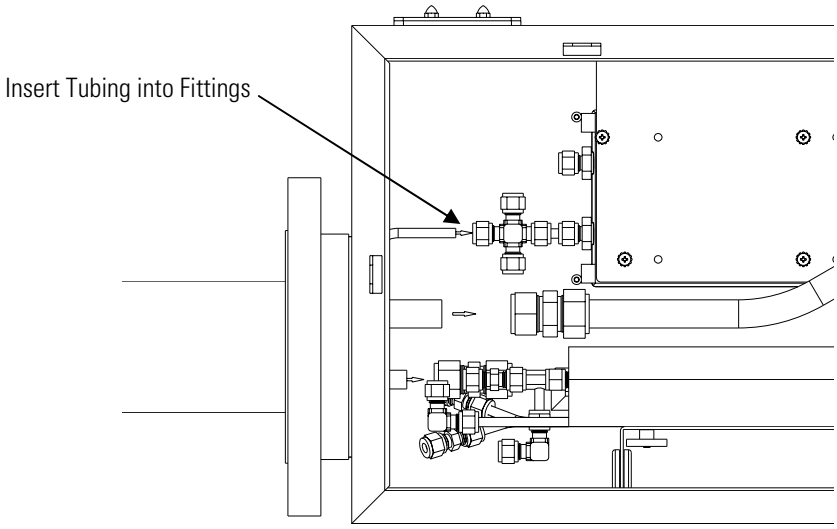


Figure 2–6. Sample Tubing Connections

8. Insert the return tube into the 3/4-inch union on return loop.

9. Compress fittings at mantle end. Refer to probe terminal block (Figure 2–7 and Table 2–2) and terminate stinger heater, SO_3 generator stitch heater, and T.C. leads.

10. Tighten the three nylon nuts to secure the fast loop table and the four nylon nuts for the generator assembly.

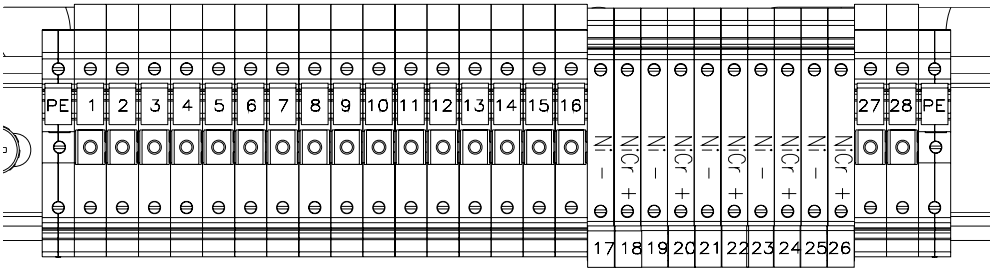


Figure 2–7. Probe Terminal Block

Table 2–2. Probe Terminal Block Heater and Thermocouple Wire Connections

From	Description	Probe Terminal Block Position
H1 (Factory)	Probe Heater 1	1
H1 (Factory)	Probe Heater 1	2
H2 (Factory)	Probe Heater 2	1
H2 (Factory)	Probe Heater 2	2
H3 (Factory)	Orifice Heater	3
H3 (Factory)	Orifice Heater	4
H4 (Factory)	Generator Heater	5
H4 (Factory)	Generator Heater	6
H5 (Installation Termination)	Stinger Heater	7
H5 (Installation Termination)	Stinger Heater	8
H6 (Installation Termination)	Spike Heater	9
H6 (Installation Termination)	Spike Heater	10
TC1 – RED (Factory)	Probe TC	17
TC1 – YEL (Factory)	Probe TC	18
TC2 – RED (Factory)	Orifice TC	19
TC2 – YEL (Factory)	Orifice TC	20
TC3 – RED (Factory)	Generator TC	21
TC3 – YEL (Factory)	Generator TC	22
TC4 – RED (Installation Termination)	Stinger TC	23
TC4 – YEL (Installation Termination)	Stinger TC	24
TC5 – RED (Installation Termination)	Spike TC	25
TC5 – YEL (Installation Termination)	Spike TC	26

Stinger Clamps Installation

Every 18-inches, add a stinger clamp (Figure 2–8).

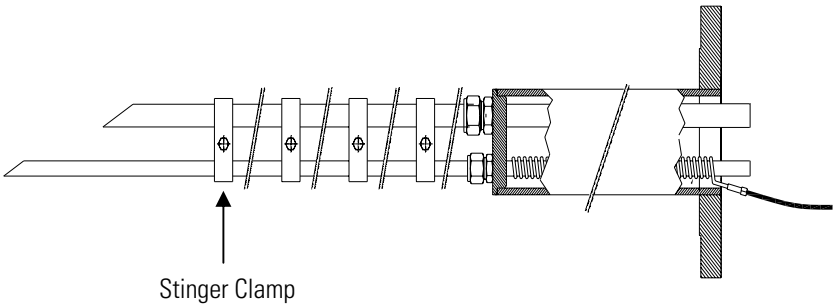


Figure 2–8. Stinger Clamp

Ash Deflector Installation

Use the following procedure to install the deflector into the inlet stinger (Figure 2–9).

1. Slide ash deflector over tip of Sample tube. Position Sample tube tip in center of deflector.

2. Use a 5/32-inch Allen head wrench to tighten the two of the rings to the sample tube with the round side facing stack flow.

3. Using 9/64-inch Allen head wrench, lock in place.

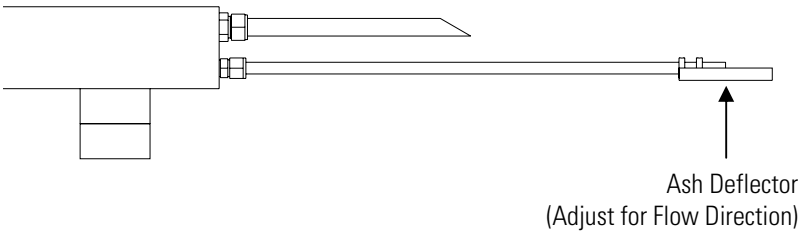


Figure 2–9. Ash Deflector

Mounting the Mantle to Stack

Depending on work area, manpower, and other site specific criteria, you may opt to install the mantle and probe at once, or the mantle first, and then the probe.

Use the following procedure to mount the mantle to stack.

1. Align mantle thru holes (Figure 2–10) to stack sample port thru holes, so probe is in desired position. Refer to Figure 2–11 and install hardware in four places.

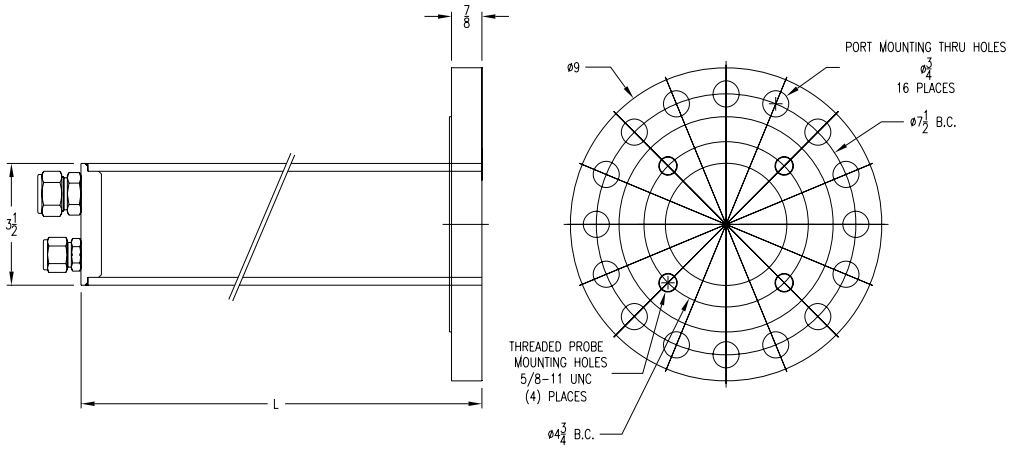


Figure 2–10. Mantle with Universal Mounting Flange

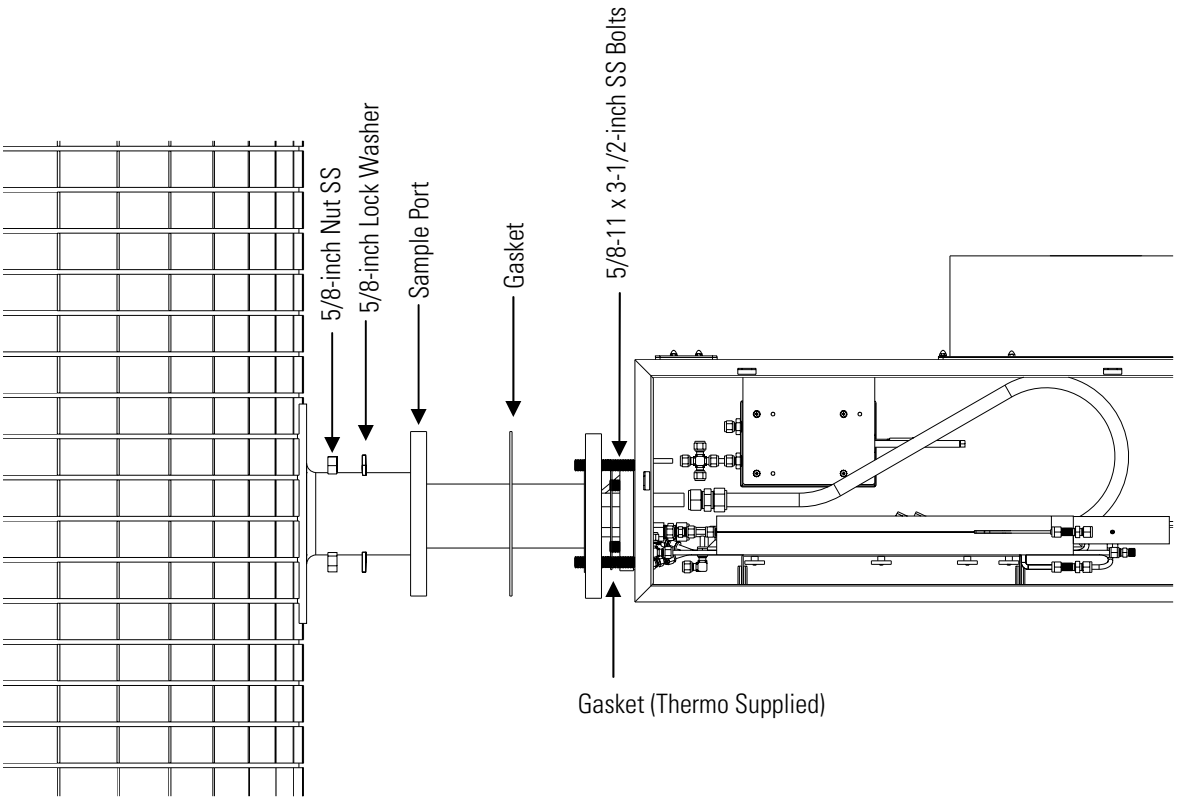


Figure 2–11. Mantle Mount

Umbilical Plumbing Hookup

Figure 2–12 shows the umbilical plumbing hookup.

There are two umbilical lines that connect the probe to the SO_3 instrument. One is a single heated line (sample). The other contains "cold" tubes to supply compressed air, and signal to the probe.

Attach hotline umbilical cord to probe as shown in Figure 2–14. Attach 1/4-inch stainless steel tubing to the atmospheric dump union and bend tubing so that air flow is directed out of probe.

After mounting probe and securing umbilical cord (hot line) in probe with 3-inch strain relief, make the connections described in Table 2–2.

Refer to Figure 2–12, Figure 2–7, and Table 2–2 for umbilical wiring hookup.

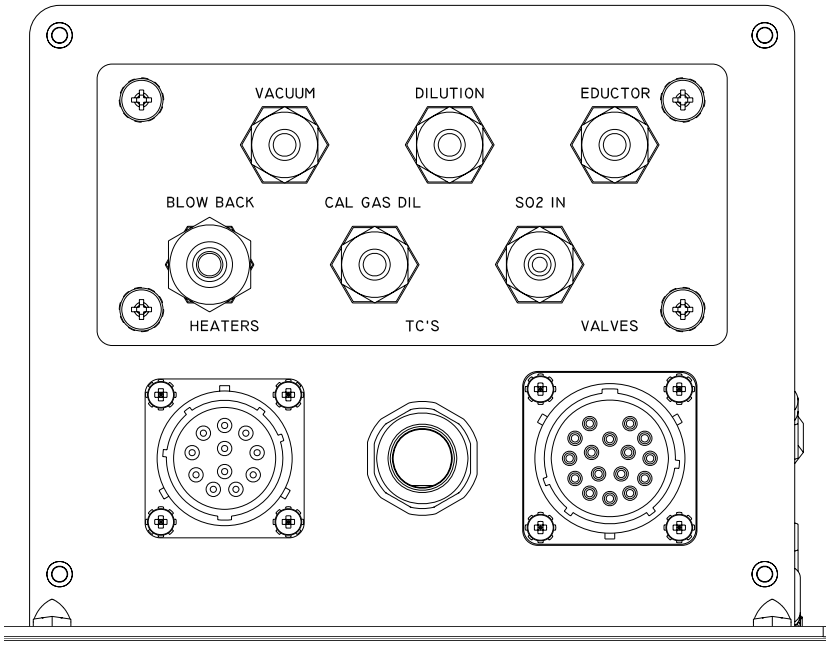


Figure 2–12. Umbilical Plumbing Hookup

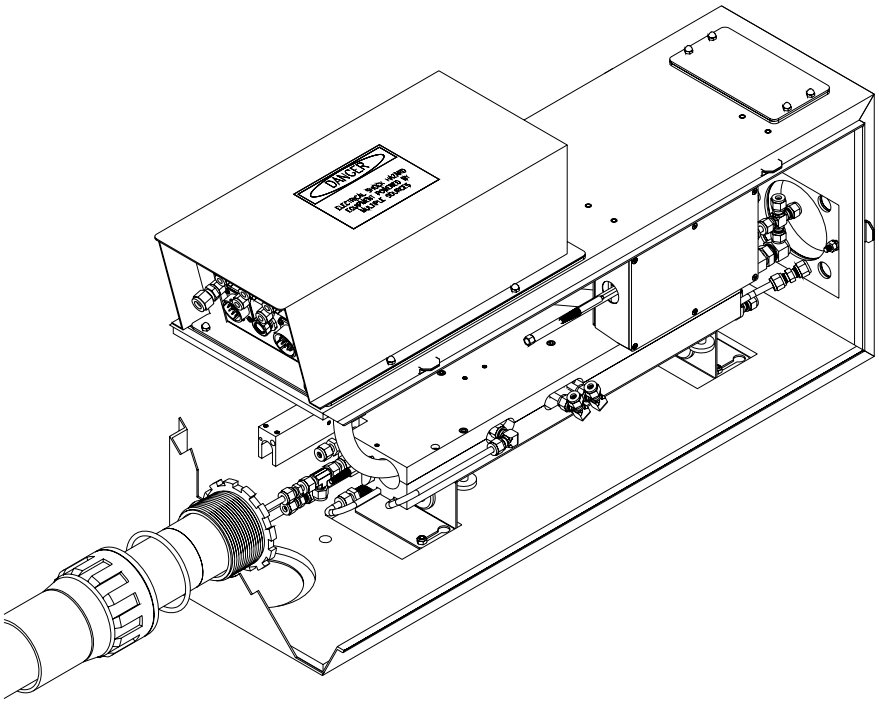


Figure 2–13. Hot Line Hook-Up Straight

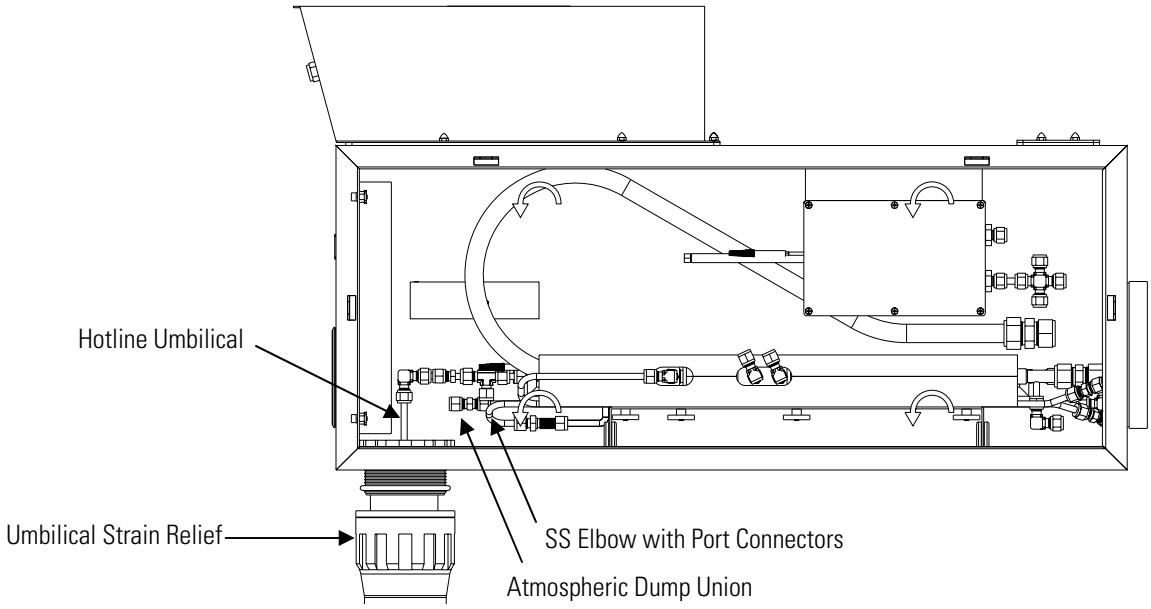


Figure 2–14. Hot Line Hook-Up Underside

Start up Procedure

Use the following procedure to start the instrument.

2. Turn OFF AC MAIN Switch on the right exterior of the cabinet (Figure 2–15).

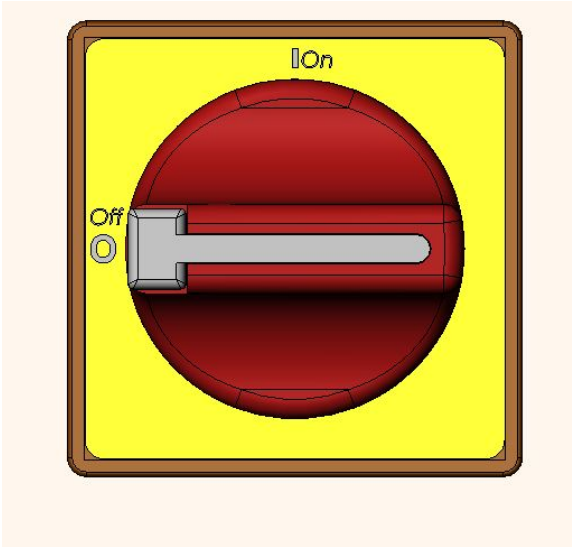


Figure 2–15. AC Main Power Switch

3. Turn 3 breakers inside the instrument box to the OFF position (Figure 2–16).

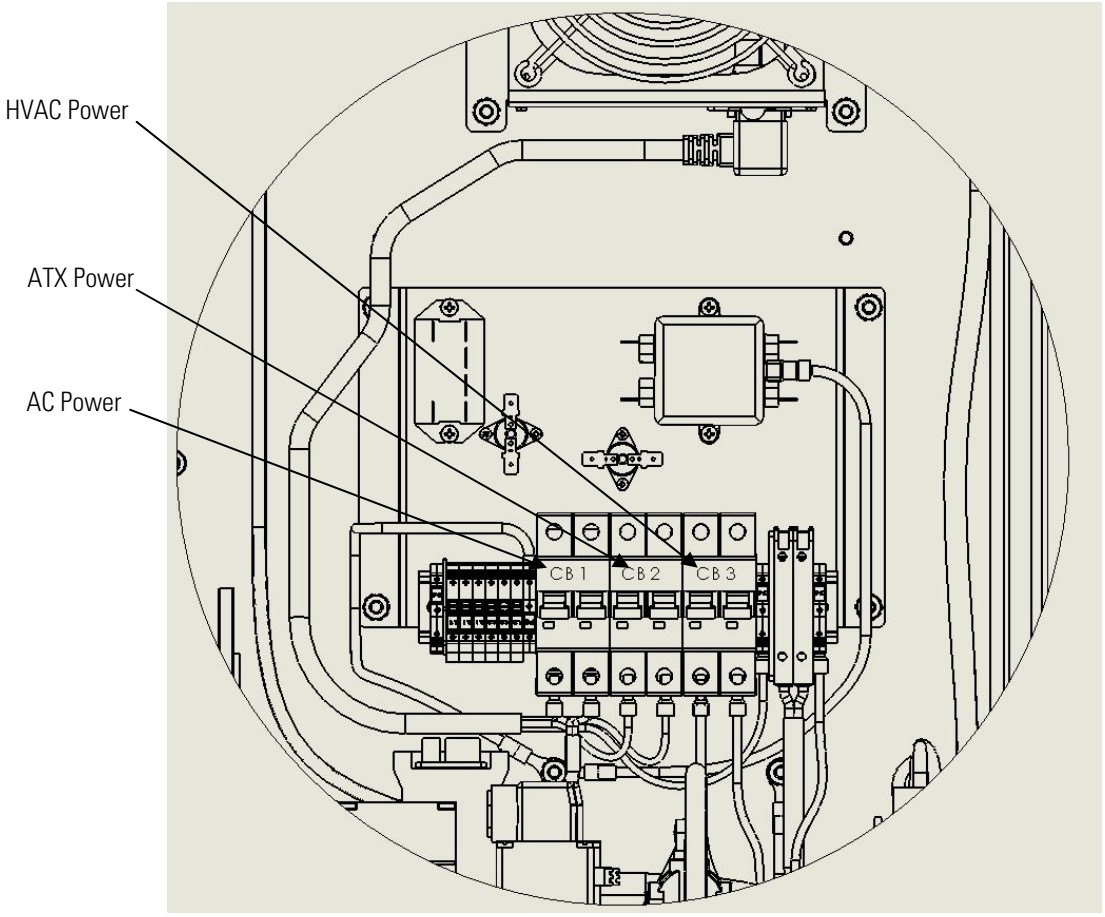


Figure 2–16. Circuit Breaker Diagram for Startup

4. Locate 30 amp electrical service drop and verify supply voltage (200 to 250 VAC).

5. Plug in main power cord.

6. Turn ON AC MAIN Switch on the right exterior of the cabinet (Figure 2–15).

7. Turn ON center breaker (CB2 ATX Power Supply).

8. Ensure that the power switch on the ATX power supply in the ON position.

9. The touch screen will start up and it may take a minute before the run screen is available.

10. Check to see that both Laser and Laser Housing temperature control boards have LEDs illuminated.

11. Check to see that the system control board has green LEDs illuminated.

HVAC

Use the following procedure to start and validate the functionality of the HVAC unit.

1. Turn on the right most circuit breaker which supplies 208 VAC power to the HVAC unit attached to the chassis. Once the HVAC is started, you should detect that the internal fan is on. At this point try to keep the main door of the enclosure closed as much as possible during the rest of start up.

Temperature Control Board Verification

Use the following procedure to start and validate the functionality of the Laser Cooler and Laser Housing Cooler.

1. Ensure that the Laser Housing Temperature at the screen System Status and Alarms > Instrument Status is maintaining the setpoint temperature. This may take up to a minute. Ensure that the temperature is stable for 5 minutes.

2. Accurate Laser temperature, as opposed to the Laser Housing temperature, is more critical to the proper operation of the instrument. The Laser Cooler setpoing temperature, found at the screen System Status and Alarms > Instrument Status, is set at the factory and should not be changed unless a channel peak offset is seen during calibration. See the "Laser Controls" section in chapter 3 for information on how to change the laser temperature.

Note Upon Startup, the Laser Cooler will automatically be turned ON when the Laser Housing Cooler temperature is within its alarm limit. The Laser Cooler cannot be turned ON unless the Laser Housing Cooler is ON and within alarm limits. ▲

3. After 6 or 7 minutes of turning the system ON, ensure that the Laser Temperature at the screen, System Status and Alarms > Instrument Status, is within 0.5 °C of the set temperature and is able to maintain constant temperature for 10 minutes.

Power Distribution

Use the following procedure to power Probe and Instrument heaters and devices.

1. Ensure the left most circuit breaker is set to the OFF position.

2. Go to Instrument Controls > Component Power and ensure all heaters are set to OFF.

3. Under System Status and Alarms, ensure the following setpoints are set according to Table 2–3.

Table 2–3. Heater Default Setpoints

Heater Description	Setpoint Degrees C
Generator Stitch	300
Umbilical Stitch	220
Generator	425
Orifice Stitch	300
Probe	275
Umbilical	275
Bench	220
Stinger	350

4. Switch the left most circuit breaker to the ON position.

5. Check to see that the Power Distribution Board has 10 red LEDs illuminated.

6. If any of the LEDs are not illuminated, turn OFF AC Power Distribution breaker and change out the fuses for the corresponding LED.

Equipment Damage If the bench heater is ON, ensure that the instrument door is either open or that the Air Conditioning unit is ON. If the bench heater is ON with the door closed and the Air Conditioning OFF, thermal damage to the boards may occur. ▲

7. Under Instrument Controls > Component Power > **Instrument**, turn Bench heater ON. Check under the System Status and Alarms menu to ensure that the temperature is climbing toward setpoint.

8. Under Instrument Controls > Component Power > **Probe**, turn on each of the heaters one at a time. Check under the System Status and Alarms menu to ensure that the temperature of each component climbs toward the setpoint. Again, power up each circuit, one at a time, and check the corresponding termperature to ensure the thermocouple and heaters are not crossed.

9. Check to see that all the temperatures control to within 5 °C of their corresponding setpoints. This may take up to 60 minutes. Temperature setpoints and values are located in the System Status and Alarms menu.

Chapter 3
User Interface

This chapter describes the functionality of the touch screen user interface. For details, see the following topics:

- "Instrument Display" on page 3-2
- "SO3 Screen and Keypads" on page 3-6
- "Thermo Scientific Information Screen" on page 3-9
- "Calibration Menu" on page 3-11
- "Instrument Controls Menu" on page 3-25
- "System Status and Alarms Menu" on page 3-40
- "Data Analysis Menu" on page 3-48
- "Service Menu" on page 3-63
- "Export to USB Flash Drive" on page 3-86

Instrument Display

To access instrument display touch screen, push in on small door near latch and pull plug. The Instrument Display (Figure 3–1) consists of various Main Menu buttons located on the left side, as illustrated by the flowchart in Figure 3-XX and Figure 3-0XX. These include Calibration, Instrument Controls, System Status and Alarms, Data Analysis, and Service. The **SO_3 Screen** button and Contact Information button are located at the top of the display and the **Back** button at the lower right. The Status Bar at the bottom center displays the system gas mode, active alarms status, and date and time.

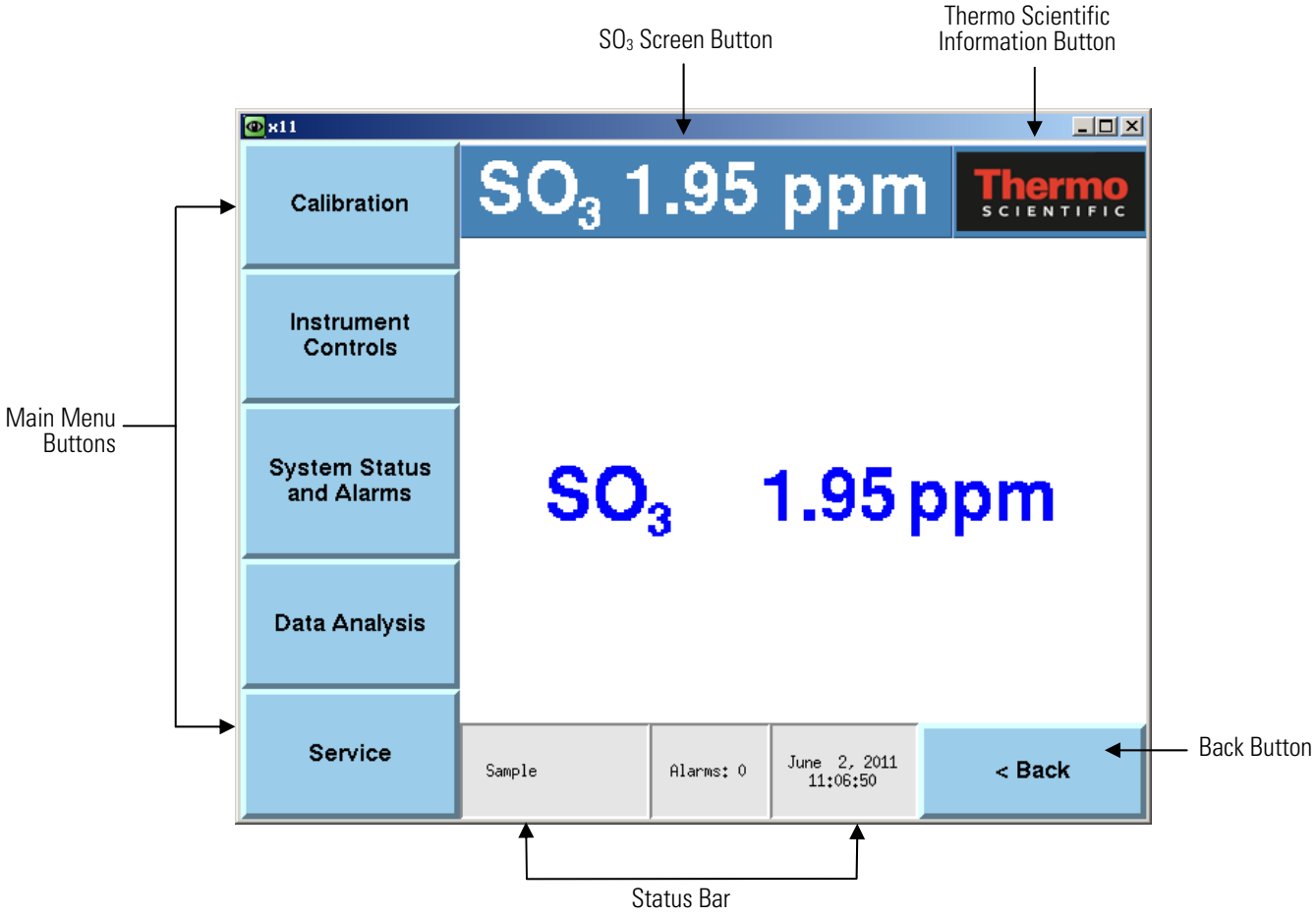


Figure 3–1. Instrument Display

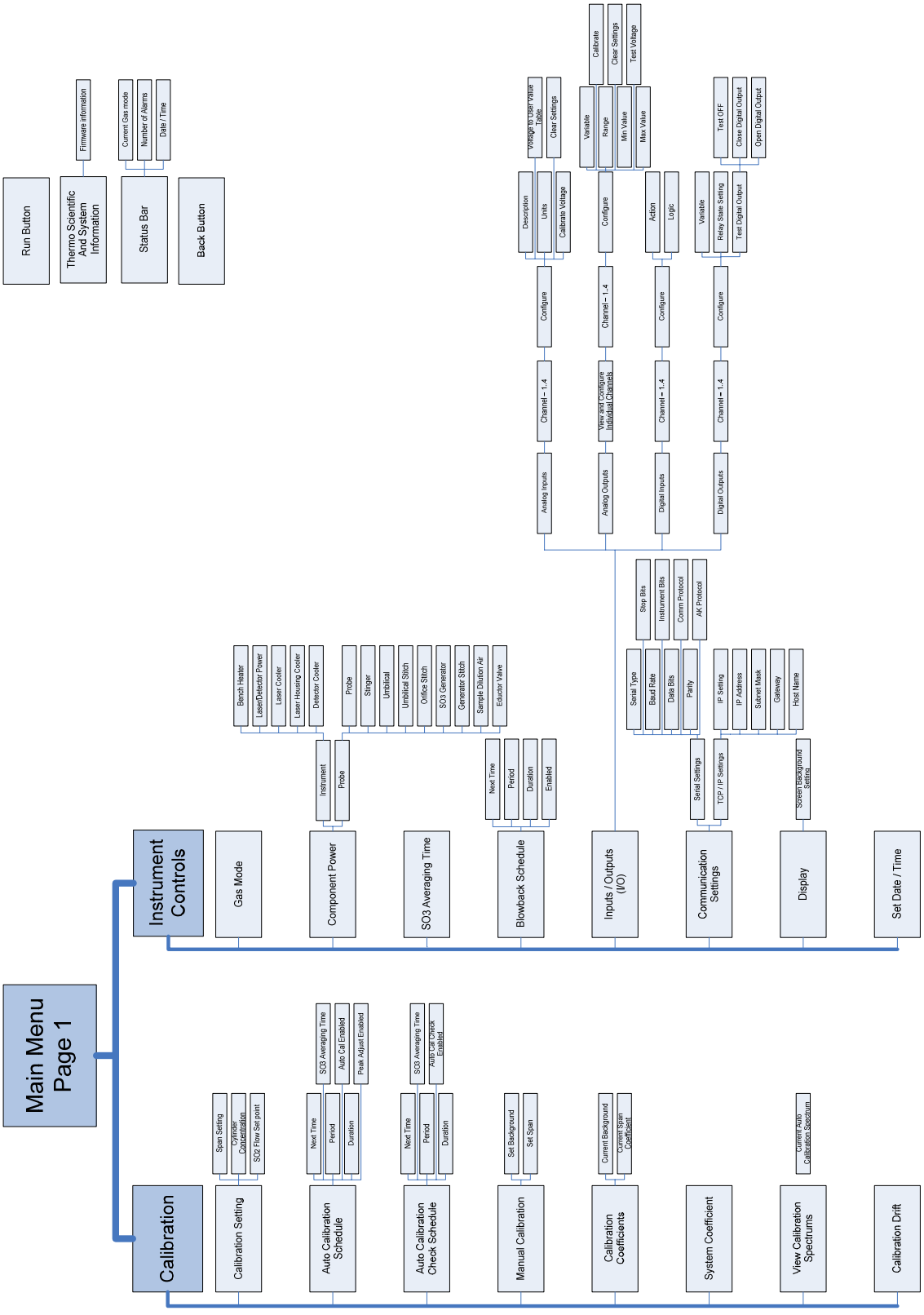


Figure 3–2. Main Menu page 1

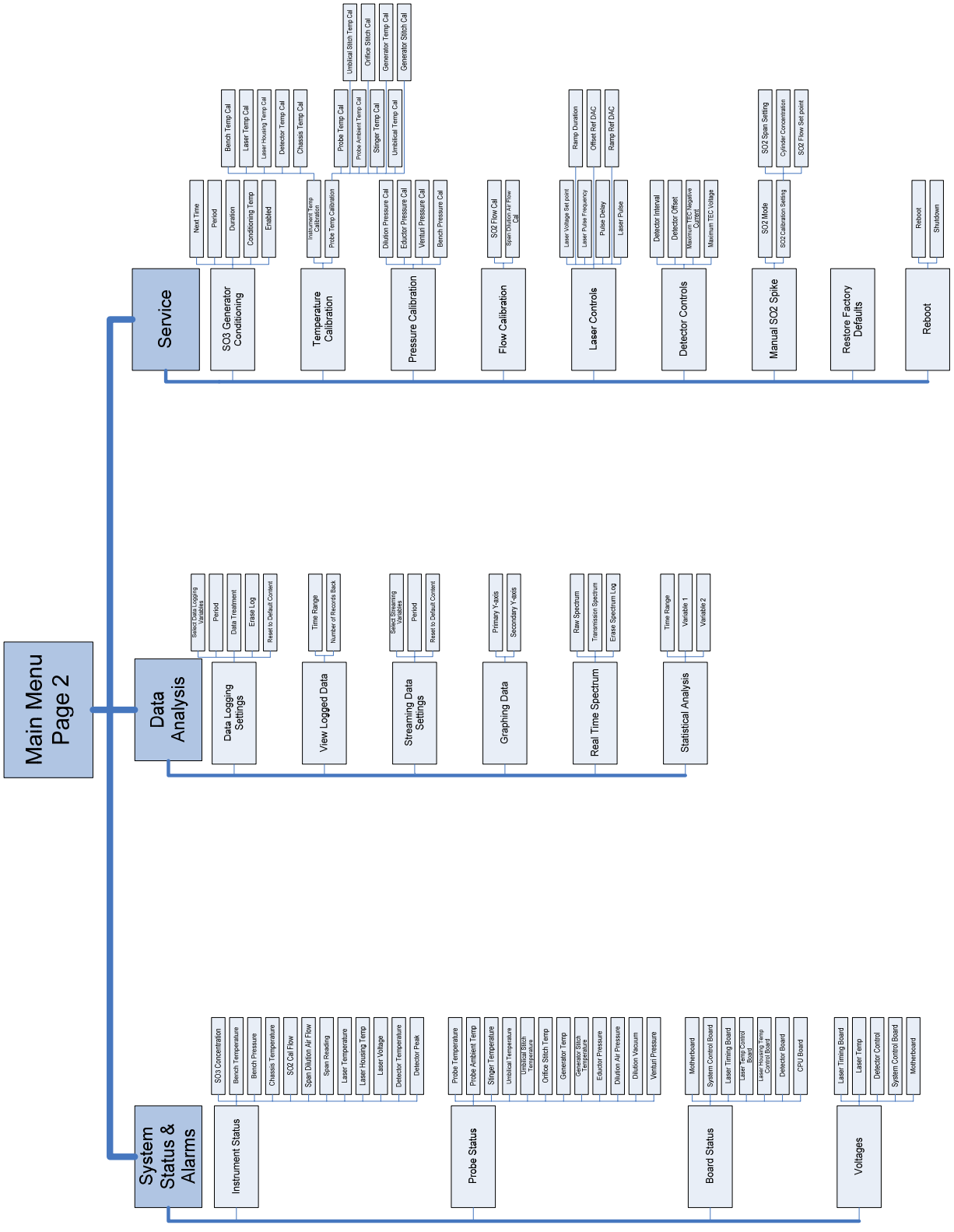


Figure 3–3. Main Menu page 2

The Instrument Display contains the following information:

- *SO_3 Screen button:* Displays the title "SO_3 CEMS" when in the SO_3 screen and the current SO_3 concentration reading when in all other screens. When pressed, it brings you back to the SO_3 screen.
- *Thermo Scientific Information button:* Shows the contact information, product information, serial numbers, board firmware versions and software build numbers.
- *Main Menu buttons:* Includes Calibration, Instrument Controls, System Status and Alarms, Data Analysis, and Service buttons.
    - *Calibration.* Allows the user to calibrate the system, setup automatic calibrations, and view calibration data.
    - *Instrument Controls.* Contains controls for operating the system.
    - *System Status and Alarms.* Shows real-time temperature, pressure, flow values, etc., setpoints, alarms and alarm limits.
    - *Data Analysis.* View, graph, and analyze data.
    - *Service.* Sets and calibrates temperatures, pressures, and flows. Sets sensitive parameters for the Laser and Detector. Also allows the user to set the SO_3 generator conditioning schedule.
- *Status Bar:* Displays the system gas mode, active alarm status, date and time.
    - *System Gas Mode.* Displays current gas mode.
    - *Alarms.* Displays the number of active alarms.
    - *Date/Time.* Displays current date and time.
- *Back Button:* When pressed, displays the previous screen.

SO_3 Screen and Keypads

The SO_3 Screen (Figure 3–4) shows SO_3 concentration in big, bold characters. The SO_3 screen button, located at top-center, brings you to the SO_3 Screen.

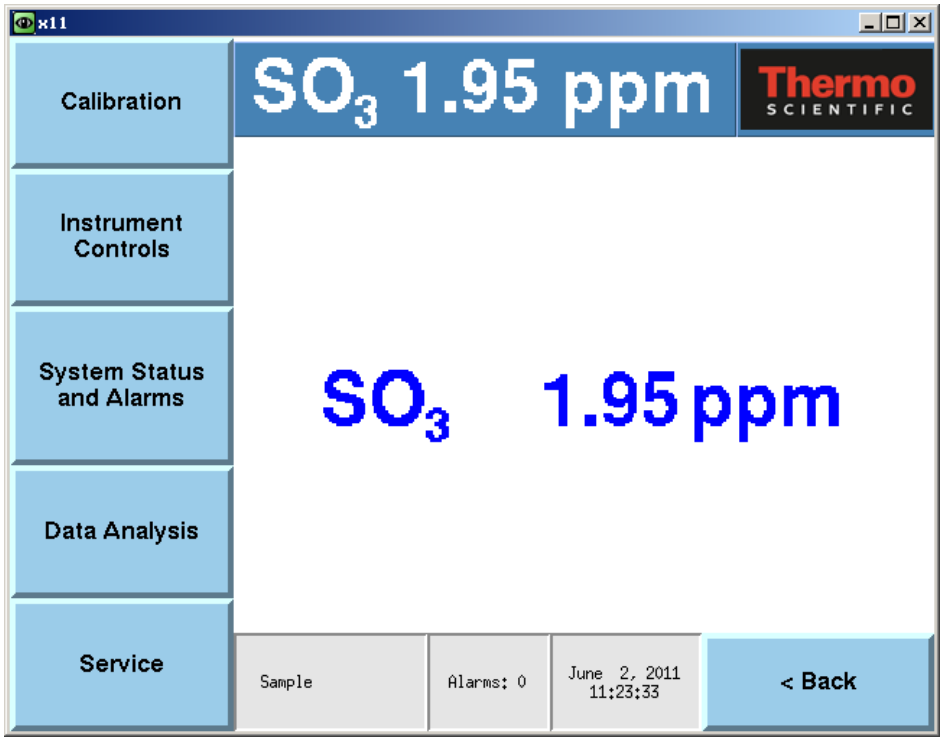


Figure 3–4. SO_3 Screen

Numeric Keypad Screen

User enters a value into the box using the number keypad (Figure 3–5). When the user needs to change a value, such as for flow rates, temperatures or pressures, the keypad screen will automatically display. Initially, the box above the keypad will display the current value. Enter a new value using the keypad, and then select the **Enter** button to set the new value or press the **Cancel** button to exit the keypad screen and return to the previous screen without saving the value.

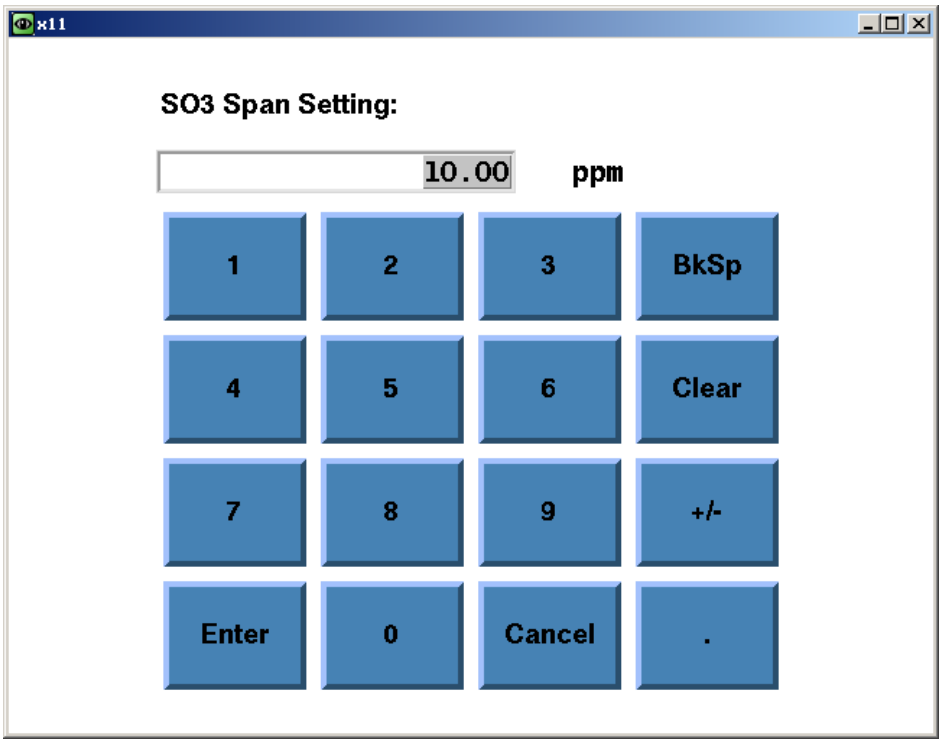


Figure 3–5. Numeric Keypad Screen

Alpha-Numeric Keypad Screen

User enters a value into the box using the keypad (Figure 3–6). When the user needs to change an alpha-numeric value, this keypad will automatically display. Initially, the box above the keypad will display the current value. Enter a new value using the keypad, and then select the **Enter** button to set the new value or press the **Cancel** button to exit the keypad screen and return to the previous screen without saving the value. The alpha-numeric keypad is only available when the user needs to enter alphabet characters.

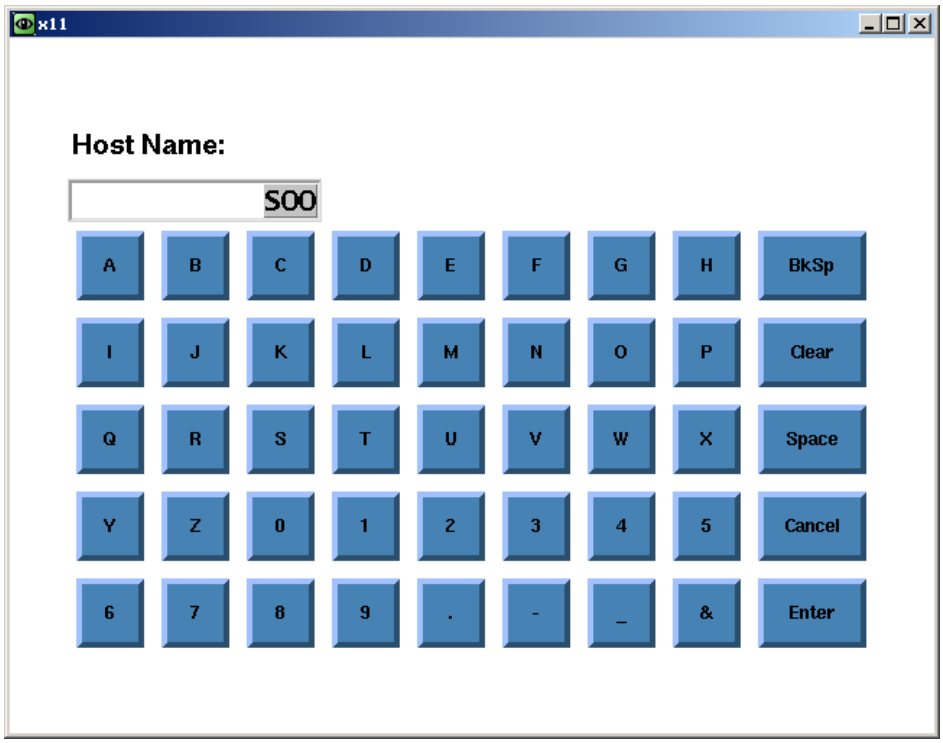


Figure 3–6. Alpha-Numeric Keypad Screen

Thermo Scientific Information Screen

The Thermo Scientific Information screen (Figure 3–7) lists Thermo Scientific's Air Quality Instruments Division contact information. Also, it lists the system information.

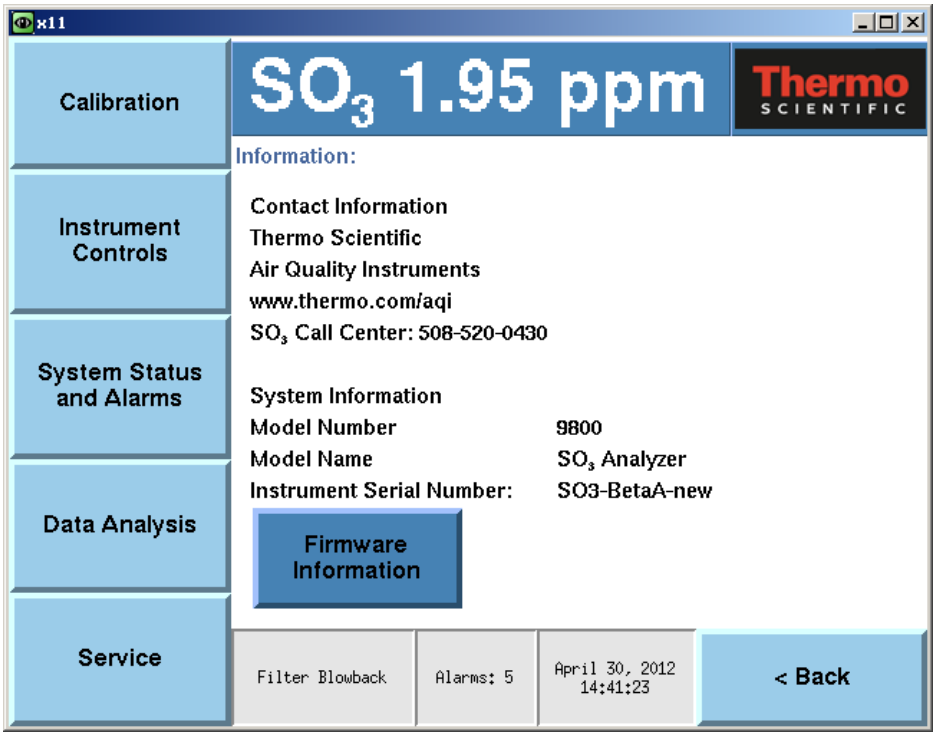


Figure 3–7. Information Screen

The Information screen contains the following information:

- *Contact Information:* Customer service information.
- *System Information:* Lists model number, name, and instrument serial number information.
- *Firmware Information:* Lists board firmware information and software build information.

Firmware Information

The Firmware Information screen (Figure 3–8) lists board firmware information and software build information.

Note Customer version numbers may differ. ▲

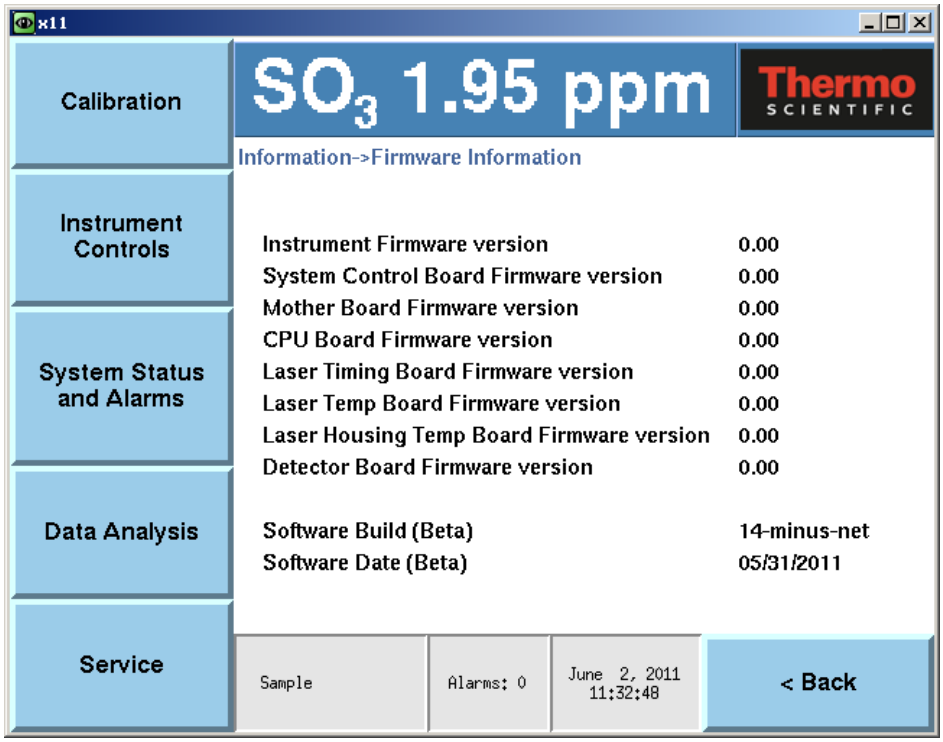


Figure 3–8. Firmware Information Screen

Calibration Menu

The Calibration Menu (Figure 3–9) provides several ways to calibrate the system. See Chapter 4 "Calibration" for further instructions on how to run a calibration.

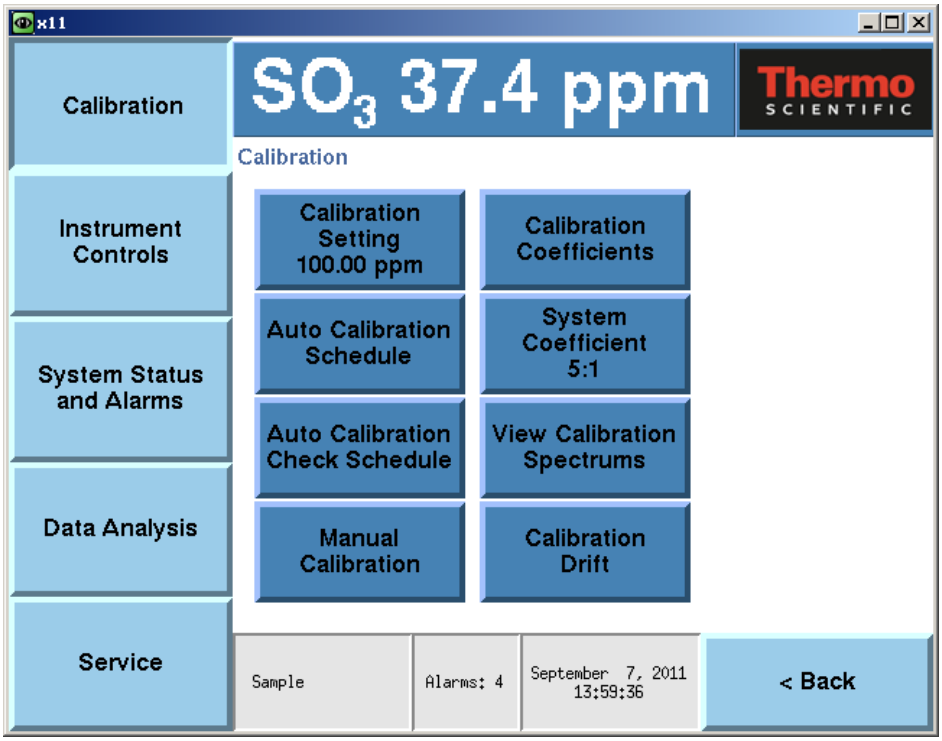


Figure 3–9. Calibration Screen

The Calibration Menu contains the following buttons:

- *Calibration Setting:* Sets the variables needed to get the correct SO_3 span concentration.
- *Auto Calibration Schedule:* Automatically runs a background and span at designated times. This will calibrate the system by setting a new background and new span coefficient. This screen will also allow the user to enable an automatic "Peak Adjust" whereby the SO_3 peak will be centered at channel 0 by adjusting the laser temperature.
- *Auto Calibration Check Schedule:* Automatically runs a background and span at designated times. This schedule does not change background or span coefficient variables, and does not calibrate the system.
- *Manual Calibration:* The user manually calibrates the background or span coefficient based on the current SO_3 concentration value.
- *Calibration Coefficients:* Manually sets the background or span coefficient using the keypad.

- *System Coefficient:* This value is a multiplier for the SO_3 concentration based on the probe dilution assembly and other system settings.
- *View Calibration Spectrums:* The transmission spectrum that the current automatic calibration is based on will be saved. Allows the user to view the calibration spectrum from the end of the last automatic calibration.
- *Calibration Drift:* Provides information for the last two automatic calibrations.

Calibration Setting

The Calibration Setting screen (Figure 3–10) sets the variables needed to get a desired SO_3 span concentration.

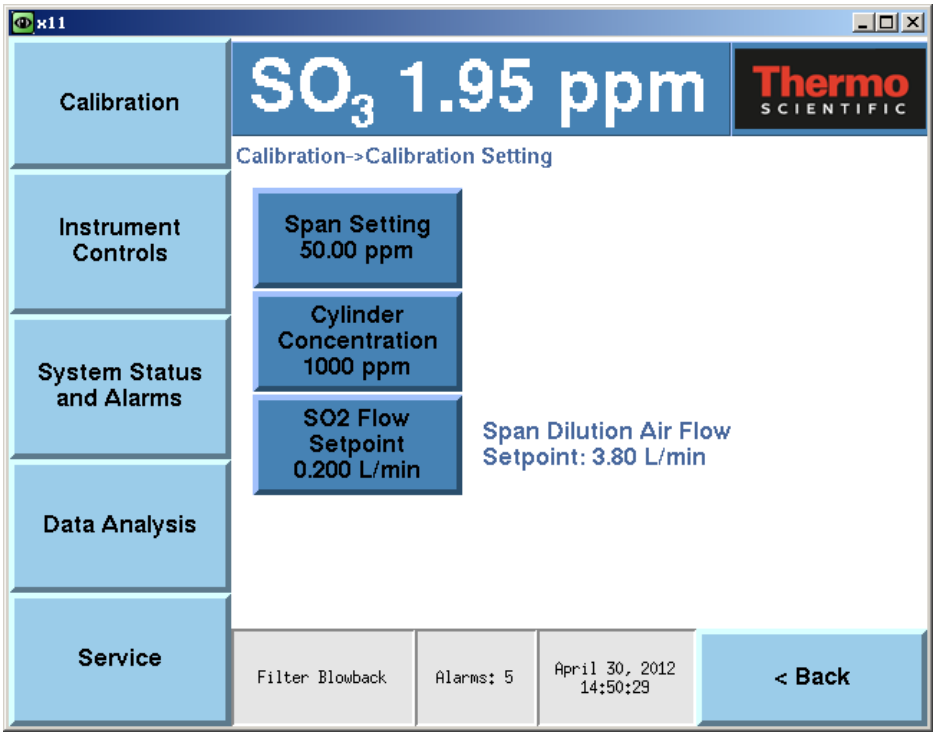


Figure 3–10. Concentration Setting Screen

The Calibration Setting screen contains the following information:

- *Span Setting*. Sets the SO_3 span concentration for calibrations.
- *Cylinder Concentration*. The Cylinder Concentration value should be set to the concentration of the SO_2 cylinder.
- *SO_2 Flow Setpoint*. The SO_2 Flow setpoint value sets the SO_2 MFC flow during calibrations. The SO_2 flow can be set between 0.02 and 0.480 cc/min.
- *Calibration Dilution Air Flow Setpoint*. The Calibration Dilution Air Flow setpoint is automatically calculated from the three variables above. The Calibration Dilution Air Flow MFC will be set to this value during calibrations.

Note The Calibration Dilution Air Flow will be displayed as red when out of the specified range of 0.20 to 9.8 L/min. An error box will pop up asking you to change the Calibration settings. Calibrations will not take place if this screen displays flow setpoint errors. ▲

Note A minimum of 3 L/min is recommended for the Span Dilution Air Flow Setpoint. ▲

Note A cylinder concentration of 1000 ppm SO_2 in Air is recommended. ▲

Auto Calibration Schedule

The Automatic Calibration Schedule screen (Figure 3–11) sets periodic automatic calibrations. It will automatically run a background and span at designated times. When run, this schedule calibrates the system by setting a new background and new span coefficient. See Chapter 4 "Calibration" for further instructions on how to run an Automatic Calibration Schedule. If "Peak Adjust" is enabled, the laser temperature will be adjusted to center the SO_3 peak on channel 0.

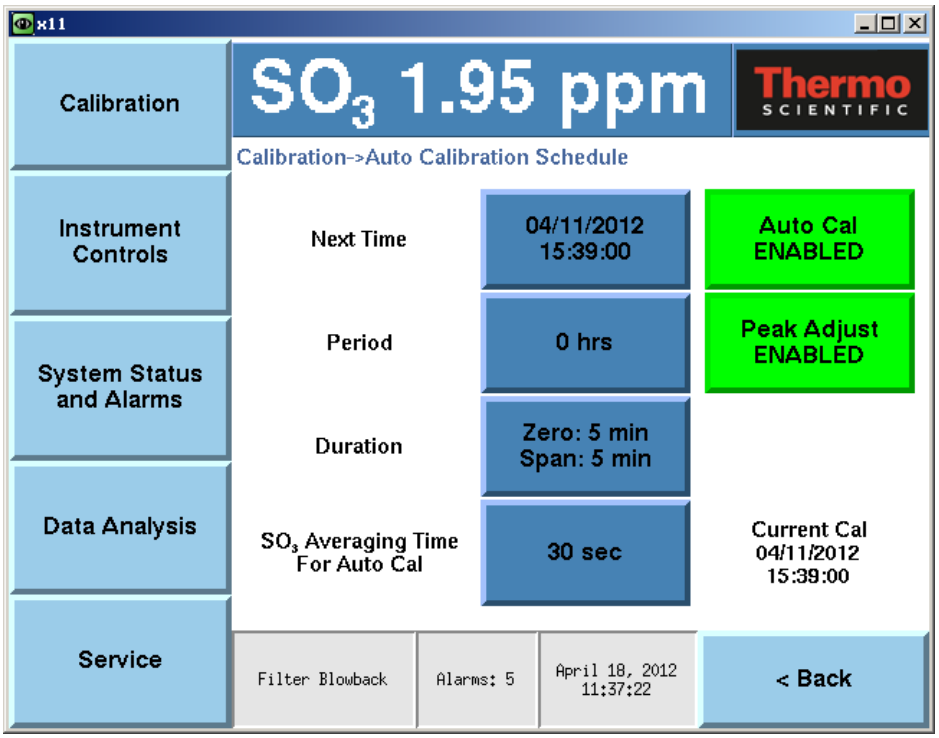


Figure 3–11. Auto Calibration Schedule Screen

The Automatic Calibration Schedule screen contains the following information:

- *Auto Cal Enabled/Disabled*. Enables/disables the auto calibration schedule state. The screen responds with "Are you Sure" and requires a Yes or No action.
- *Peak Adjust Enabled/Disabled*. Enables/disables the automatic peak adjust feature. If enabled, during an automatic calibration, the laser cooler temperature will be adjusted to center the SO_3 peak at channel 0.
- *Next Time*. Sets the date and time for the next scheduled calibration. Once an automatic calibration has started the "Next Time" button will be updated based on the "Period".

- *Period*. Sets the length of time between calibrations.
- *Duration*. Sets the length of time for zero air and span gas.
- *SO_3 Averaging Time for Auto Cal*. Sets the Averaging time during auto calibration. During an Automatic Calibration, this averaging time will override the Sample averaging time set in the Instrument Controls menu.
- *Current Calibration*. Displays the date/time of the most recently completed automatic calibration.

If an automatic calibration fails, an error message will appear in red located below the Peak Adjust button. When there is a calibration failure the Calibration Schedule will be aborted and the Current Background Coefficient and the Current Span Coefficient will be reset to the values prior to the automatic calibration attempt.

Possible automatic calibration errors:

- Zero Bkg out of range during System Zero. The new background calculated at the end of system zero is outside the acceptable range.
- Current Span Coefficient Denominator = 0. The new span coefficient is equal to zero, which is not acceptable.
- Span Coefficient out of range. The new span coefficient falls outside the range of 0.500 to 2.000.
- Zero Bkg out of range during System Span. When a new span coefficient is calculated, a new zero background is also calculated. If this new zero background falls outside the acceptable range, this error will appear.
- Span too weak during Syste Span. The SO_3 peak (between channels -10 to 10) as seen on the Transmission Spectrum screen was too weak for it to be considered an SO_3 feature.

Auto Calibration Check Schedule

The Automatic Calibration Check Schedule screen (Figure 3–12) automatically runs a background and span at designated times. This schedule does not change background or coefficient variables. See Chapter 4 "Calibration" for more information on the Automatic Calibration Check Schedule.

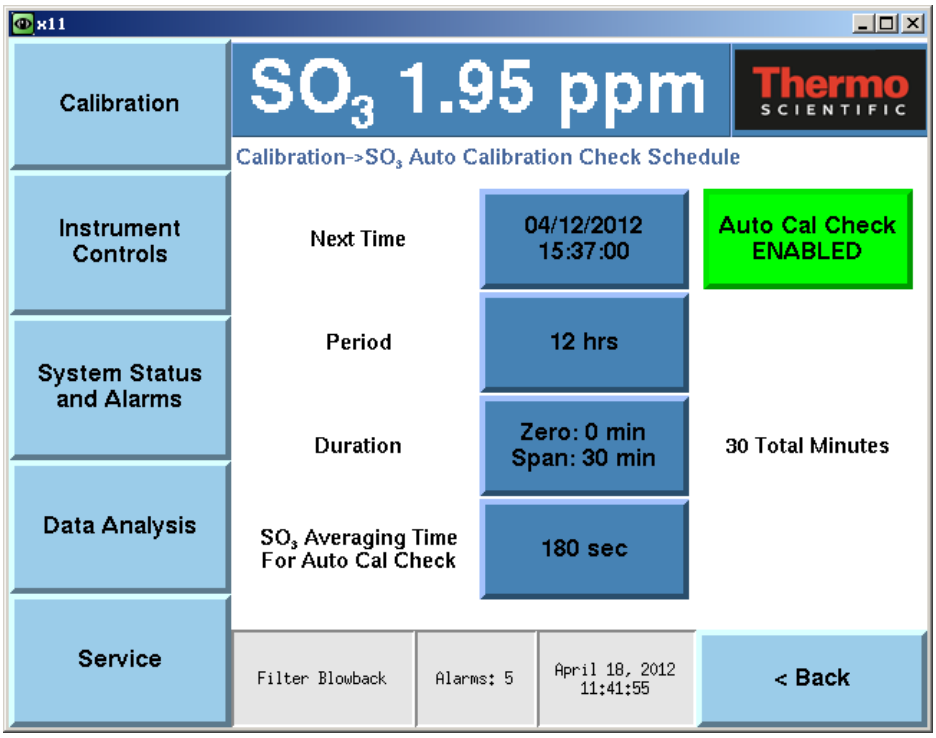


Figure 3–12. Auto Calibration Check Schedule

The Automatic Calibration Check Schedule screen contains the following information:

- *Enable/Disable*. Enables/disables the auto calibration check schedule state. The screen responds with "Are you Sure" and requires a Yes or No action.
- *Next Time*. Sets the date and time for the next scheduled calibration check. Once an automatic calibration check has started the "Next Time" button will be updated based on the "Period".
- *Period*. Sets the length of time between calibration checks.
- *Duration*. Sets the length of time for zero air and span gas.
- *SO_3 Averaging Time for Auto Cal Check*. Sets the Averaging time during calibration check. During an Automatic Calibration Check, this

averaging time will override the averaging time set in the Instrument Controls menu.

Manual Calibration

The Manual Calibration screen (Figure 3–13) calibrates the background or span coefficient based on the current SO_3 concentration reading. See Chapter 4 "Calibration" for instructions on how to run a Manual Calibration.

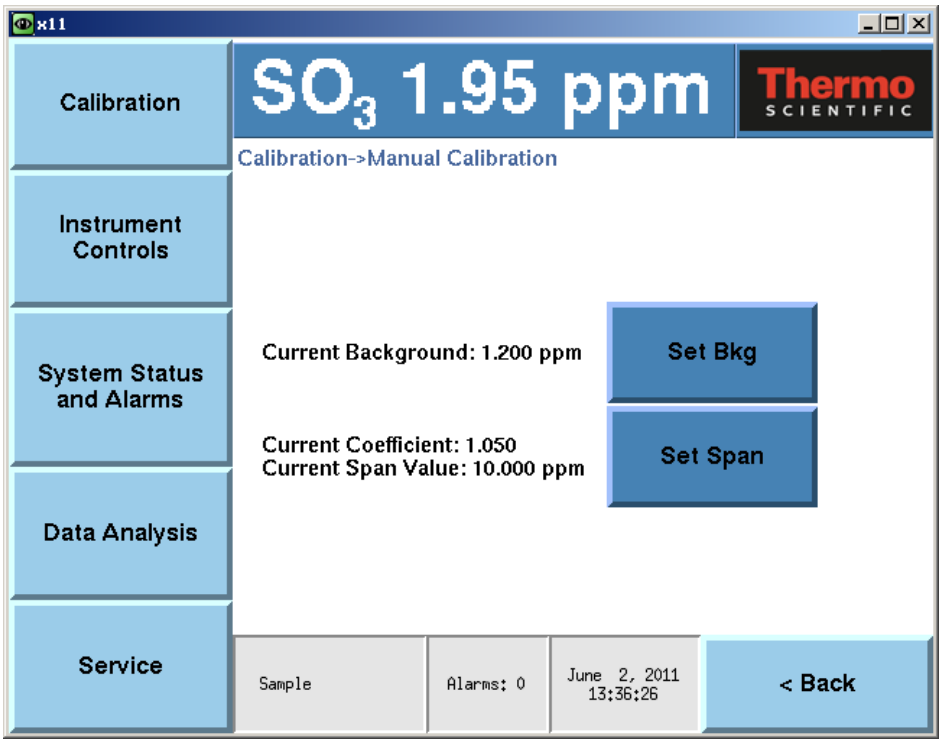


Figure 3–13. Manual Calibration Screen

The Manual Calibration screen contains the following information:

- *Set Bkg*. Manually sets a new background value based on the current SO_3 reading. The current background is displayed to the left of the button. Pressing **Set Bkg** responds with "Are you sure you want to set the current SO_3 reading to Zero?" and requires a Yes or No action.
- *Set Span*. Sets new span coefficient based on the current SO_3 reading and the actual span reading found at System Status and Alarms > Instrument > Span Reading. The current coefficient and span value setpoint are displayed to the left of the button. Pressing **Set Span** responds with "Are you sure you want to set the current SO_3 concentration reading to the Span value of ## ppm?" and requires a Yes or No action.

Calibration Coefficients

The Calibration Coefficients screen (Figure 3–14) manually sets the background or span coefficient using the keypad.

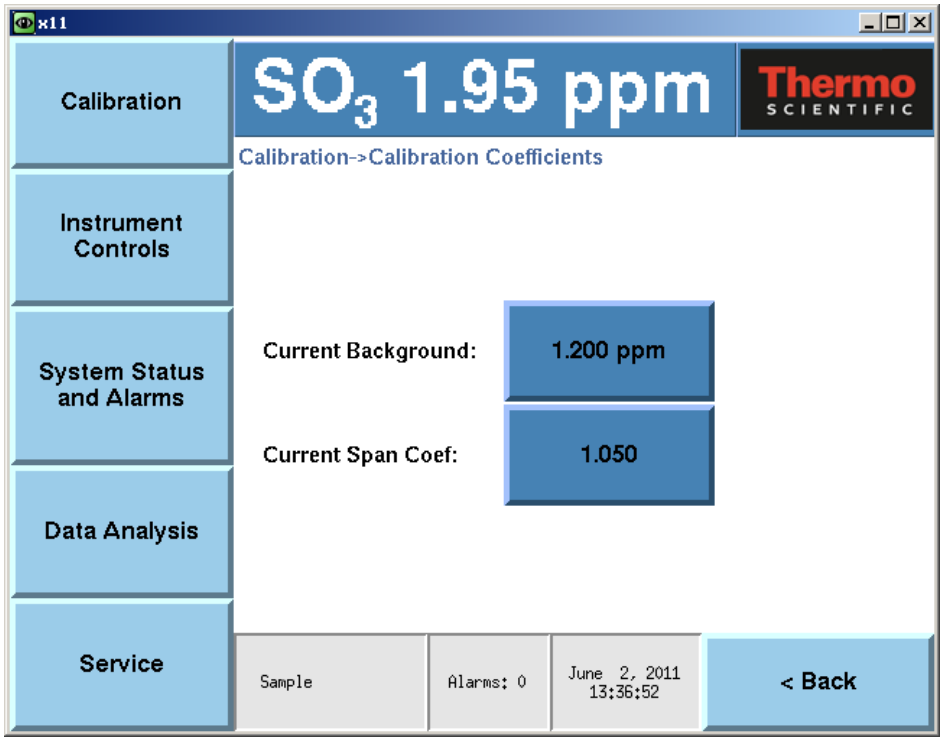


Figure 3–14. Calibration Coefficients Screen

The Calibration Coefficients screen contains the following information:

- *Current Background*. Displays the current background. When pressed, the numeric keypad will be displayed and a new background may be entered and saved.
- *Current Span Coefficient*. Displays the current coefficient. When pressed, the numeric keypad will be displayed and a new span coefficient may be entered and saved.

System Coefficient

The System Coefficient screen (Figure 3–15) is a multiplier for the SO_3 concentration based on the Probe dilution assembly and other system and software factors. This setting should not need to be changed often. Clicking on this will bring up the keypad. For instance, if the user has 100 ppm span gas going through the system but the concentration reading is reading 200 ppm then the user can reduce the system coefficient by half to get a more reasonable concentration.

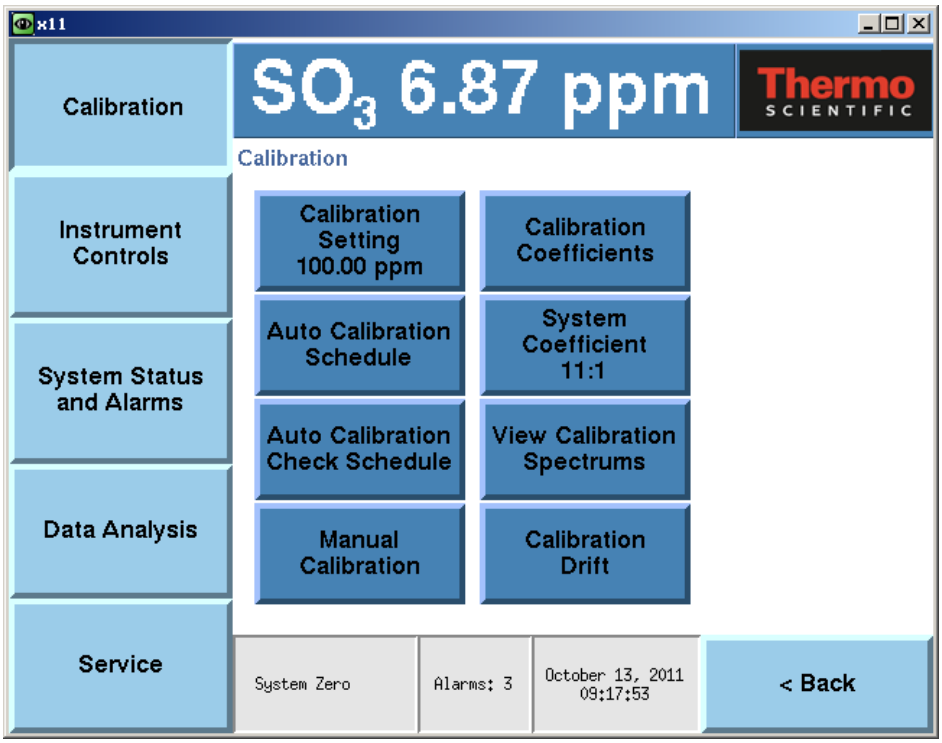


Figure 3–15. System Coefficient Screen

Note Before changing the system coefficient, span gas should be run for at least 30 minutes. Also, it is recommended that the Span Coefficient be set to 1.000 at the Calibration Coefficients screen before changing the System Coefficient. When the System Coefficient is changed, a full calibration should then be performed. ▲

View Calibration Spectrum

The View Calibration Spectrum screen (Figure 3–16) displays the date of the most recently completed automatic calibration and allows the user to access the spectrum used for the automatic span calibration.

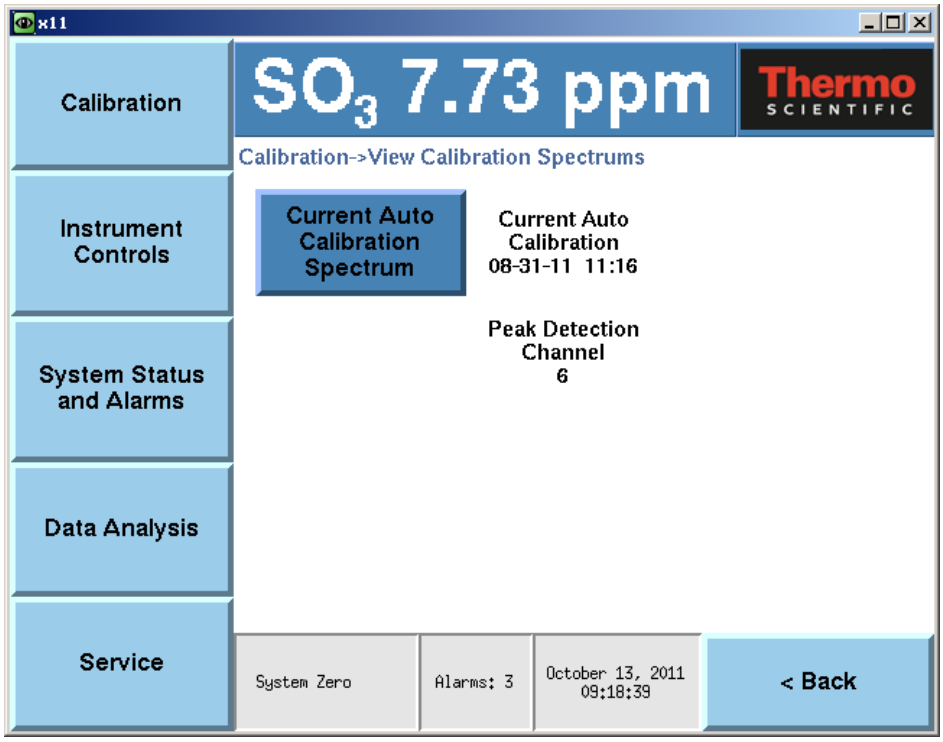


Figure 3–16. View Calibration Spectrum Screen

The Vew Calibration Spectrum screen contains the following information:

- *Current Auto Calibration Spectrum*. Pressing this button will display the transmission spectrum screenshot at the time of the last successfully completed automatic span calibration.
- *Peak Detection Channel*. The channel number where the SO_3 signal peak is located during the last successful automatic calibration is also written. The peak detection channel should be located between -5 and 5. If it is from -10 to -6 or 6 to 10, then a laser temperature adjustment should be performed in order to center the SO_3 peak near channel number 0 (see the laser controls information in the Service menu section). If the SO_3 signal peak is weak, such as when in system zero, the peak detection channel number will display “20”. During system span, if the peak detection channel equals “20”, then the SO_3 peak is most likely too weak to calibrate to.

Current Calibration Spectrum

The Current Calibration Spectrum screen (Figure 3–17) displays the transmission spectrum during the end of the last auto calibration.

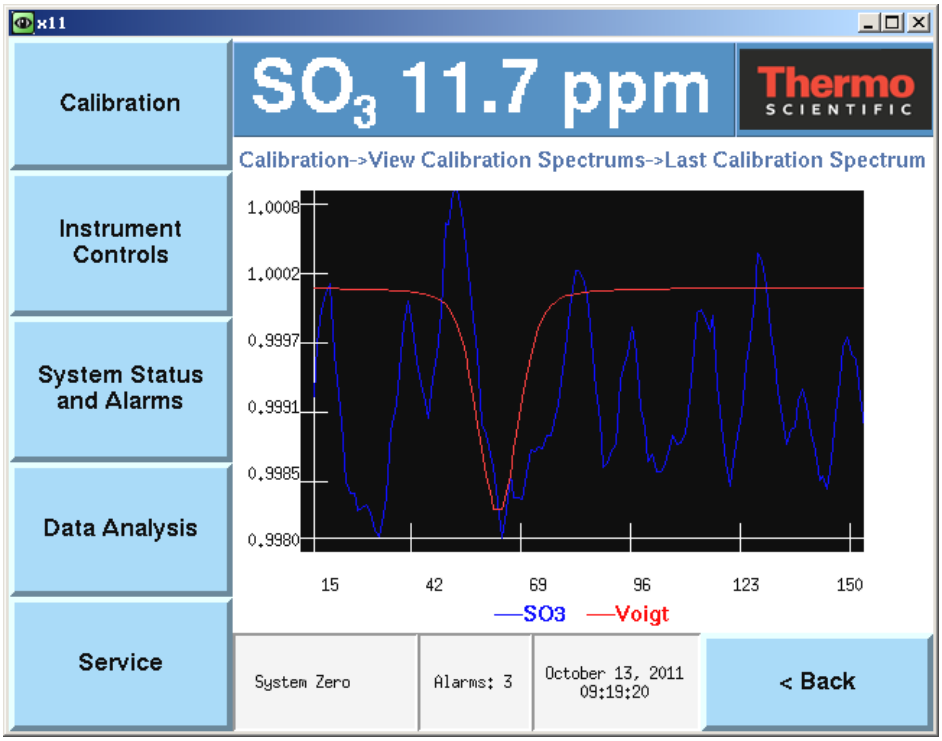


Figure 3–17. Current Calibration Spectrum Screen

The Current Calibration Spectrum screen contains the following information:

- *Blue Curve*. SO_3 transmission spectrum at the end of the last auto calibration.
- *Red Curve*. Voigt fit at the end of the last auto calibration.

Calibration Drift

The Calibration Drift screen (Figure 3–18) provides information from the last two successful *automatic* calibrations.

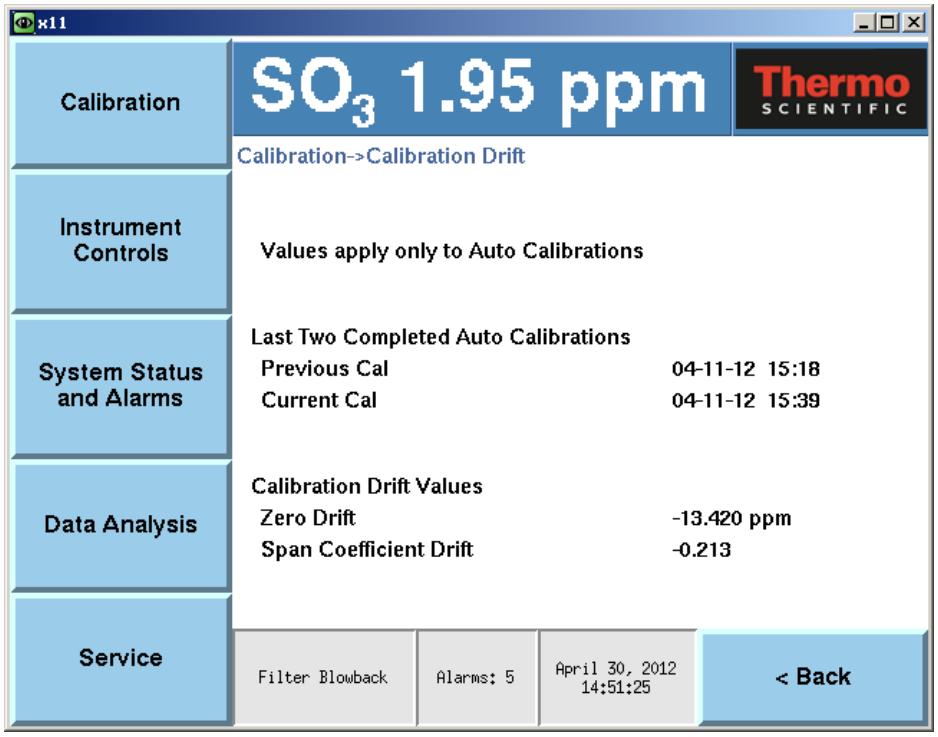


Figure 3–18. Calibration Drift Screen

The Calibration Drift screen contains the following information:

- *Previous Cal*. Date and time of the previous successful automatic calibration.
- *Current Cal*. Date and time of the most recent automatic calibration.
- *Zero Drift*. The difference between the last two zero backgrounds.
- *Span Coefficient Drift*. The difference in span coefficients between the last two automatic calibrations.

Instrument Controls Menu

The Instrument Controls Menu (Figure 3–19) allows the user to select the system gas mode, turn devices ON/OFF, and adjust instrument settings.

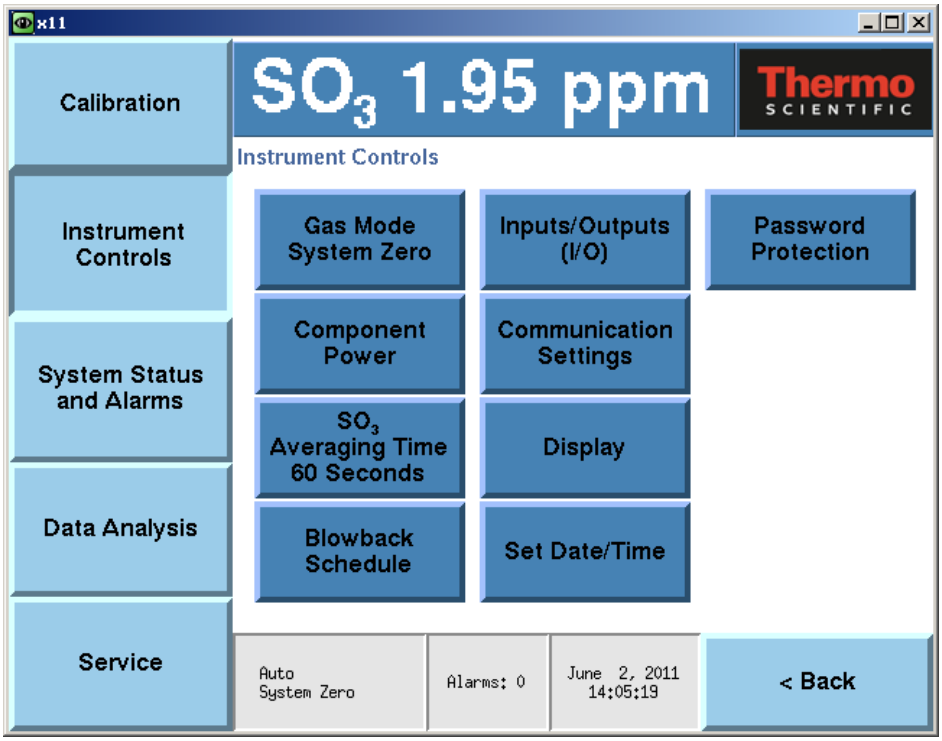


Figure 3–19. Instrument Controls Screen

The Instrument Controls Menu contains the following buttons:

- *Gas Mode:* Selects the gas mode for the system.
- *Component Power:* Turns instrument and probe devices ON/OFF
- *SO_3 Averaging Time*: Sets the averaging time for the SO_3 sample measurement.
- *Blowback Schedule:* Schedules automatic blowbacks.
- *Input/Outputs (I/O):* Sets relay settings and configurations.
- *Communication Settings:* Sets serial and TCP/IP settings.
- *Display:* Sets display settings.
- *Set Date/Time:* Sets system date and time.

Gas Mode

The Gas Mode screen (Figure 3–20) allows the user to manually select the gas mode they want the system to be in. The current active gas mode is in yellow. The Gas Mode is also reflected in the Status Bar located at the bottom on the Instrument Display.

Upon startup, the system default Gas Mode is Filter Blowback. The system will not go into any other gas mode until all temperatures are within the Alarm limits.

Also, during normal operation if any temperature reading goes into alarm, the system will automatically default into Filter Blowback mode.

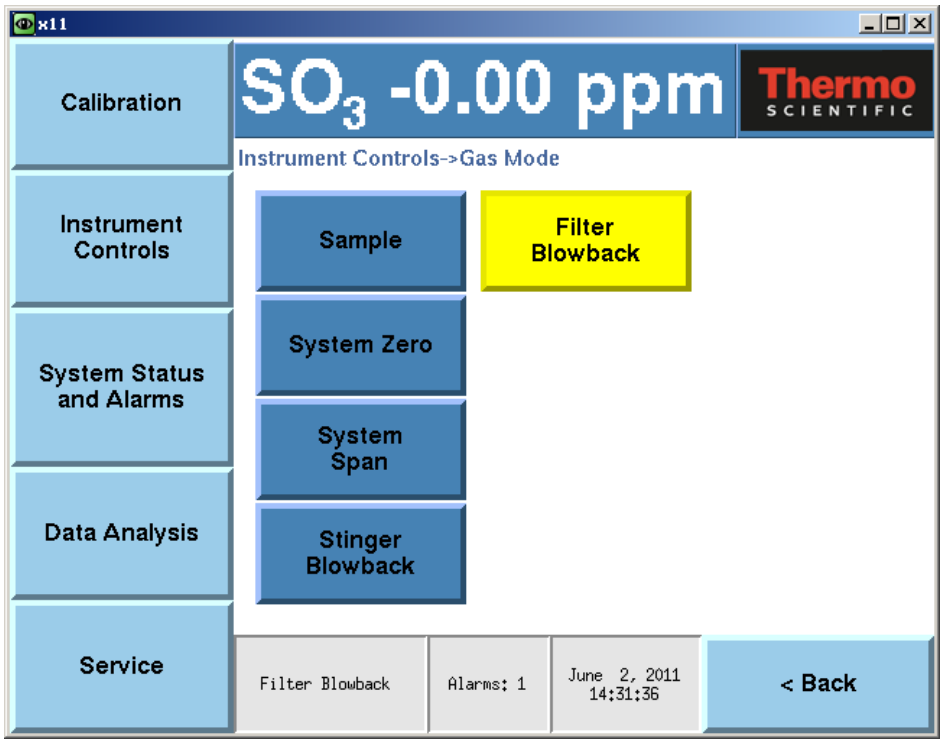


Figure 3–20. Gas Mode Screen

The Gas Mode screen selections are as follows:

- *Sample*. Probe pulls sample from the stack.
- *System Zero*. Zero air floods the probe making it possible to run and set a background measurement.
- *System Span*. Calibration gas floods the probe making it possible to calibrate the system.
- *Stinger Blowback*. Compressed air is released, blowing residue out of the stinger.

- *Filter Blowback*. Compressed air is released, blowing residue out of the probe.

Component Power

The Component Power screen (Figure 3–21) allows the user to select either Instrument or Probe component power buttons.

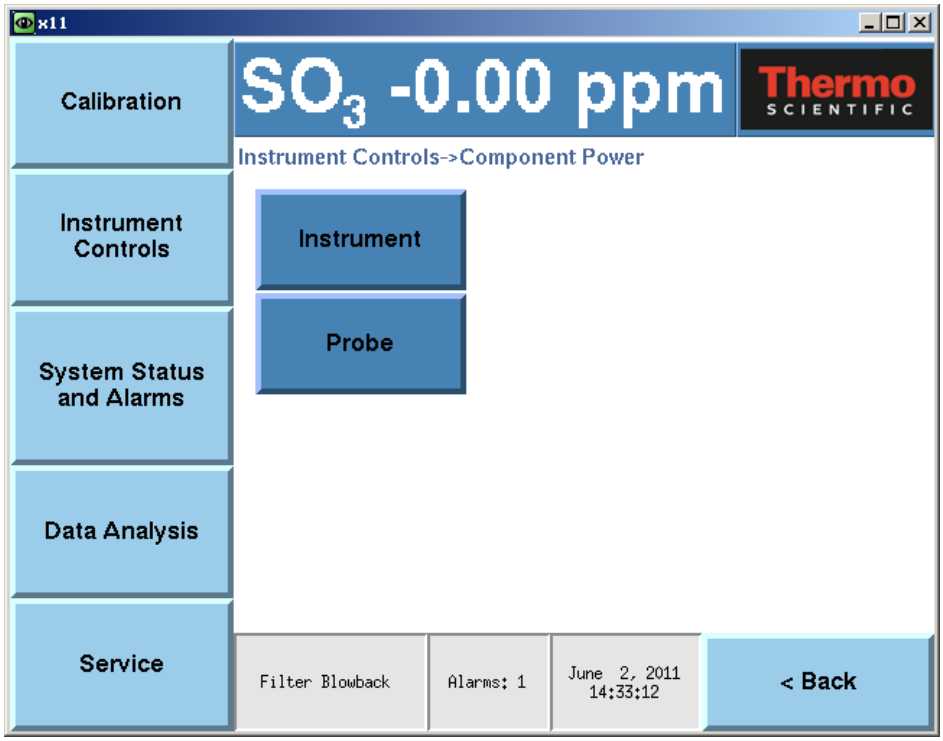


Figure 3–21. Component Power Screen

Instrument Component Power

The Instrument Component Power screen (Figure 3–22) allows the user to turn ON/OFF Instrument devices. Upon Instrument Startup, the Laser Housing Cooler, Laser Cooler, and Laser and Detector Power will automatically turn ON in that order. The entire sequence will take 5–7 minutes.

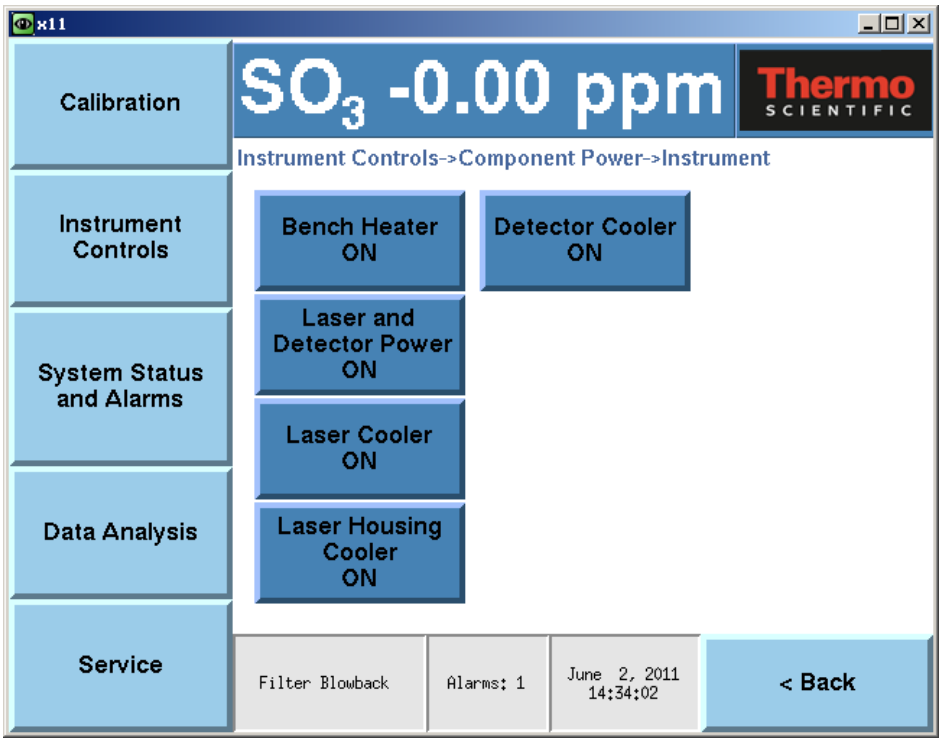


Figure 3–22. Component Power Instrument Screen

The Component Power Instrument ON/OFF options are as follows:

- *Bench Heater*. Heaters at the optical bench assembly.
- *Laser and Detector Power*. Turns the laser and detector power ON/OFF. This cannot be turned ON if either the laser housing cooler or laser cooler is OFF or if either is in an alarm state.
- *Laser Cooler*. Peltier cooler located at the laser. The laser cooler cannot be turned ON if the laser housing cooler is OFF or the temperature is in an alarm state. When the laser cooler is turned ON, it will automatically step down the laser cooler temperature incrementally until it reaches the setpoint temperature. This will take 5–7 minutes. If the laser cooler is turned OFF, the laser and detector power will automatically be turned OFF also.

- *Laser Housing Cooler*. Peltier cooler located at the laser housing. If the laser housing cooler is turned OFF, both the laser cooler and laser and detector power will automatically be turned OFF. If the laser housing temperature is ON and gets to 29 °C, it will automatically shutoff and so will the laser cooler and the laser and detector power.
- *Detector Cooler*. Peltier cooler located at the detector.

Note When cycling the power for any of the devices, the user should wait at least 30 seconds before turning power back ON. ▲

Probe Component Power

The Probe Component Power screen (Figure 3–23) allows the user to turn ON/OFF Probe devices.

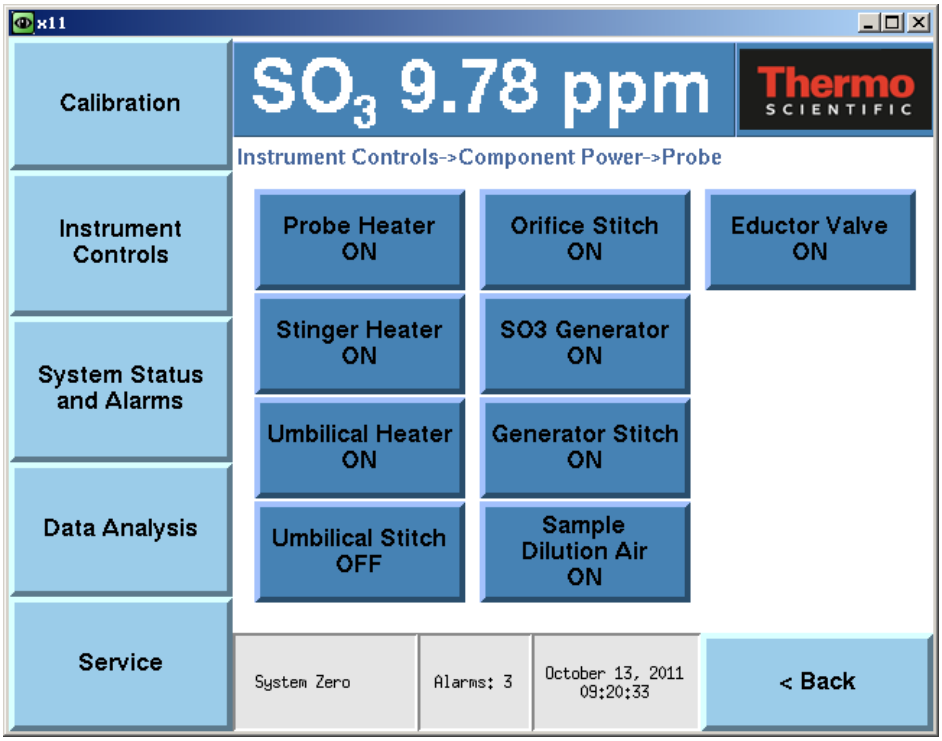


Figure 3–23. Component Power Probe Screen

The Component Power Probe ON/OFF options are as follows:

- *Probe Heater*. Heaters located in the probe clam shell assembly.
- *Stinger Heater*. The heater at the stinger assembly, which is between the stack and probe.
- *Umbilical Heater*. The heated line that runs from the probe to the instrument.
- *Umbilical Stitch*. The heated stitch of tubing going from the umbilical line to the bench. This can be lelft OFF. The umbilical stitch is not installed at the factory and will not be needed for most installations.
- *Orifice Stitch*. The heater at the sample orifice between the probe and the umbilical line.
- *SO_3 Generator*. Heaters located in the SO_3 generator assembly.
- *Generator Stitch*. The heater between the SO_3 generator and stinger.

- *Sample Dilution Air*. Turns ON/OFF the valve that supplies air to the dilution assembly.
- *Eductor Valve*. Turns ON/OFF the eductor valve.

SO_3 Averaging Time

The SO_3 Averaging Time screen (Figure 3–24) allows the user to set the averaging time for SO_3 concentration values during sample mode and the following manual modes: system zero, system span, stinger blowback, and filter blowback.

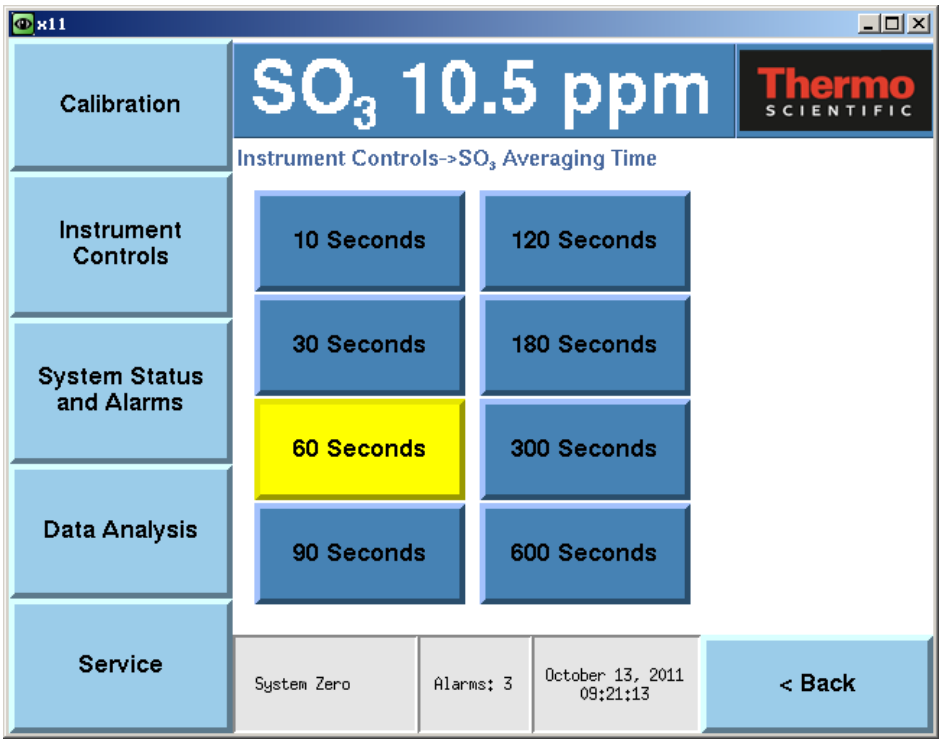


Figure 3–24. SO_3 Averaging Time Screen

Note The auto calibration schedule and auto calibration check schedule have their own settable averaging time. ▲

Blowback Schedule

The Blowback Schedule screen (Figure 3–25) sets the schedule for automated and periodic blowback events.

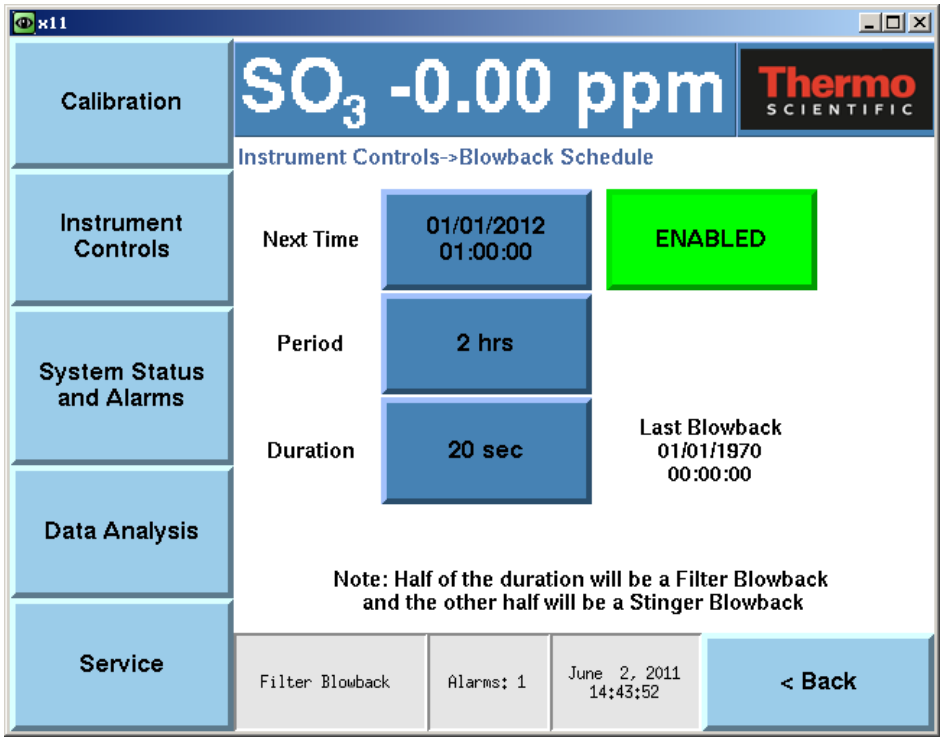


Figure 3–25. Blowback Schedule Screen

The Blowback Schedule screen contains the following information:

- *Enable/Disable*. Enables/disables the blowback schedule state. The screen responds with "Are you Sure" and requires a Yes or No action.
- *Next Time*. Sets the date and time for the next scheduled blowback event. This can be set by the user. It will also automatically be reset for the next run when a blowback cycle begins.
- *Period*. Sets the length of time between blowbacks.
- *Duration*. Sets the total time of blowback (filter and system).
- *Last Blowback*. Displays date and time of last automatic blowback.

Note Half of the duration will be a filter blowback and the other half will be a stinger blowback. ▲

Note A 2-hour blowback schedule period is recommended. ▲

Communication Settings

The Communication Settings screen (Figure 3–26) allows the user to select and configure Serial Settings and TCP/IP Settings.

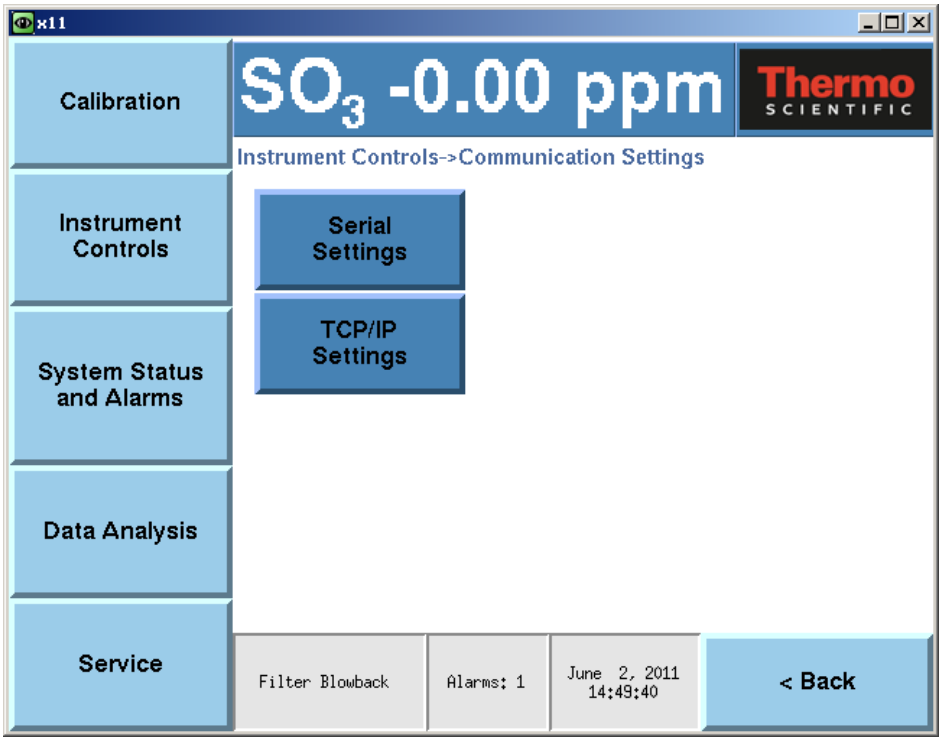


Figure 3–26. Communication Settings Screen

The Communication Settings screen contains the following information:

- *Serial Settings.* Configures serial cable communication.
- *TCP/IP Settings.* Configures network cable communication.

Serial Settings

The Serial Settings screen (Figure 3–27) allows the user to communicate with the instrument via a serial cable.

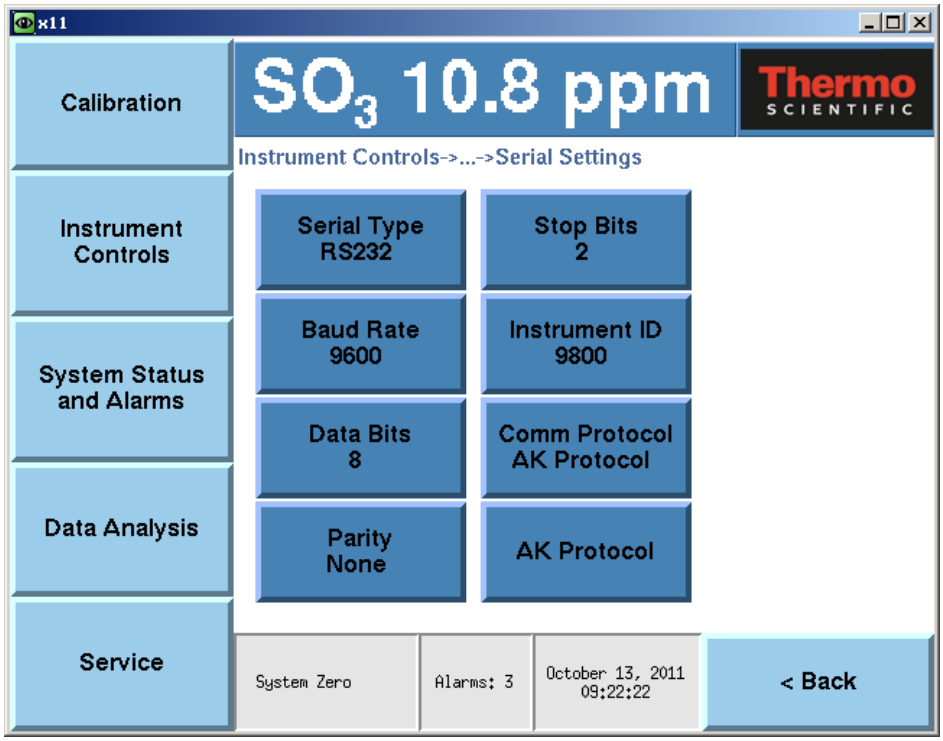


Figure 3–27. Serial Settings Screen

The Serial Settings screen contains the following information:

- *Serial Type.* Toggles between RS-232 and RS-485.
- *Baud Rate.* Toggles baud rates from 1200 to 115200.
- *Data Bits.* Toggles between 7 and 8.
- *Parity.* Toggles between None, Even, and Odd.
- *Stop Bits.* Toggles between 1 and 2.
- *Instrument ID.* Sets instrument ID with the keypad.
- *Comm. Protocol.* User selects AK Protocol, MODBUS, or Streaming.
- *AK Protocol Settings.* User configures AK Protocol settings. Station code and channel numbers can be changed.

Note The default settings are shown above. ▲

TCP/IP Settings

The TCP/IP Settings screen (Figure 3–28) allows the user to communicate with the instrument via a network cable. If the IP Setting is set to "DHCP ON", then the bottom three buttons are greyed out.

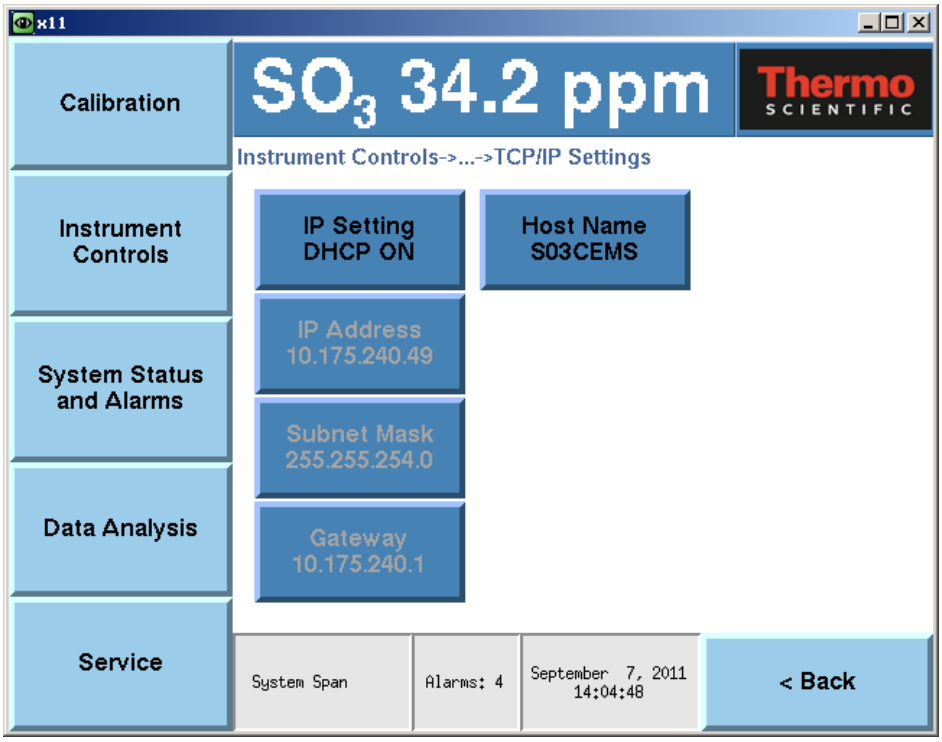


Figure 3–28. TCP/IP Settings Screen

The TCP/IP Settings screen contains the following information:

- *IP Setting.* Toggles DHCP ON/OFF.
- *IP Address.* IP address of the instrument. This is settable when DHCP is OFF.
- *Netmask.* Netmask of instrument. This is settable when DHCP is OFF.
- *Gateway.* Gateway of instrument. This is settable when DHCP is OFF.
- *Host Name.* Host name of instrument.

Note The default settings are shown above. ▲

Display

The Display screen (Figure 3–29) sets display settings. User can choose background and text color.

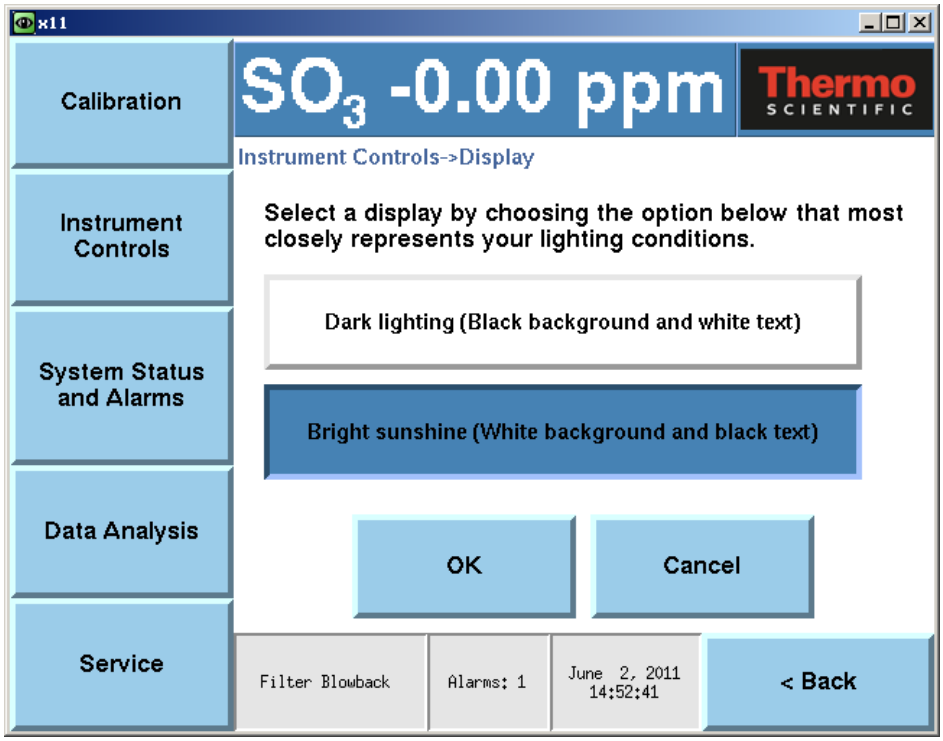


Figure 3–29. Display Screen

The Display screen contains the following information:

- *Dark Lighting.* Black background and white text.
- *Bright Sunshine.* White background and black text (Default).

Set Time Date

The Set Time/Date screen (Figure 3–30) allows the user to set the system date/time.

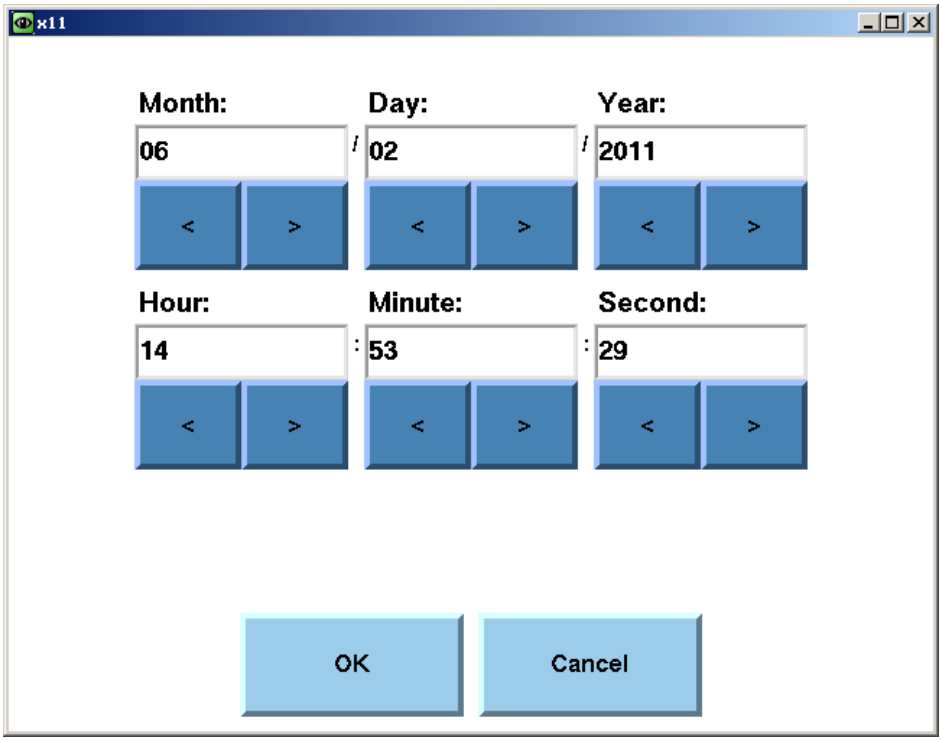


Figure 3–30. Set Date/Time Screen

System Status and Alarms Menu

The System Status and Alarms menu (Figure 3–31) allows the user to change device setpoints, view the component status, values, alarm limits and current alarms of instrument and probe devices. Also, board status and voltage readings are accessible through this menu.

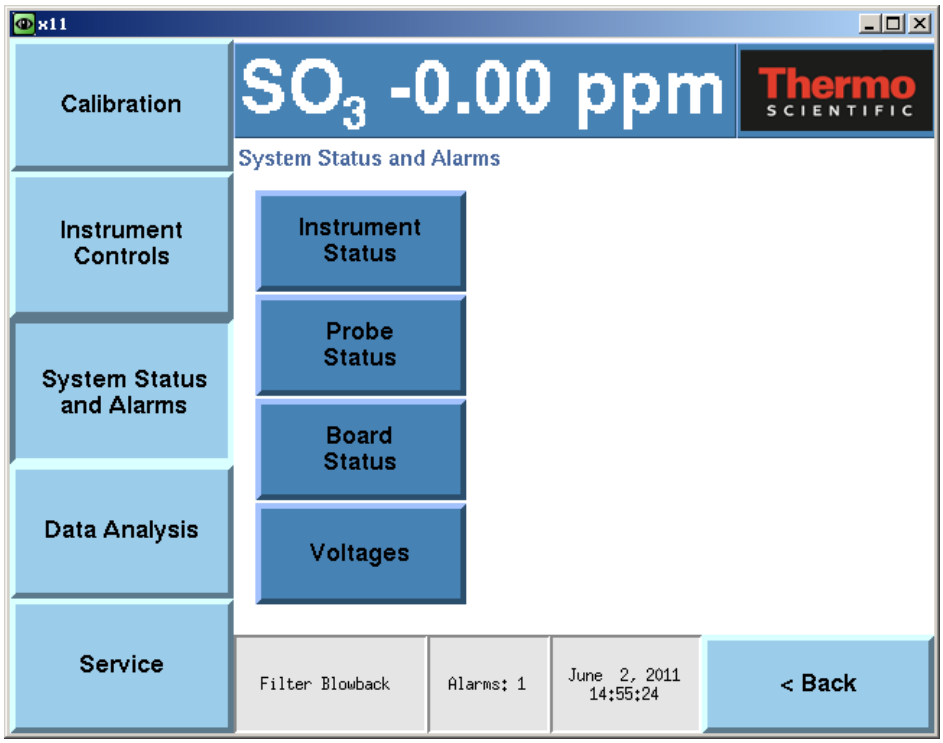


Figure 3–31. System Status and Alarms Screen

The System Status and Alarms menu contains the following buttons:

- *Instrument Status:* Displays status of instrument devices.
- *Probe Status:* Displays status of probe devices.
- *Board Status:* Displays status of each computer board.
- *Voltages:* Displays instrument voltages.

Instrument Status

The Instrument Status screen (Figure 3–32) provides information with respect to instrument components, devices, setpoints, and readings. Real-time values and alarm limits are shown. Alarm limits can be changed. Values that trigger alarms will be shown in red. Temperature and Pressure Setpoints can be viewed and changed.

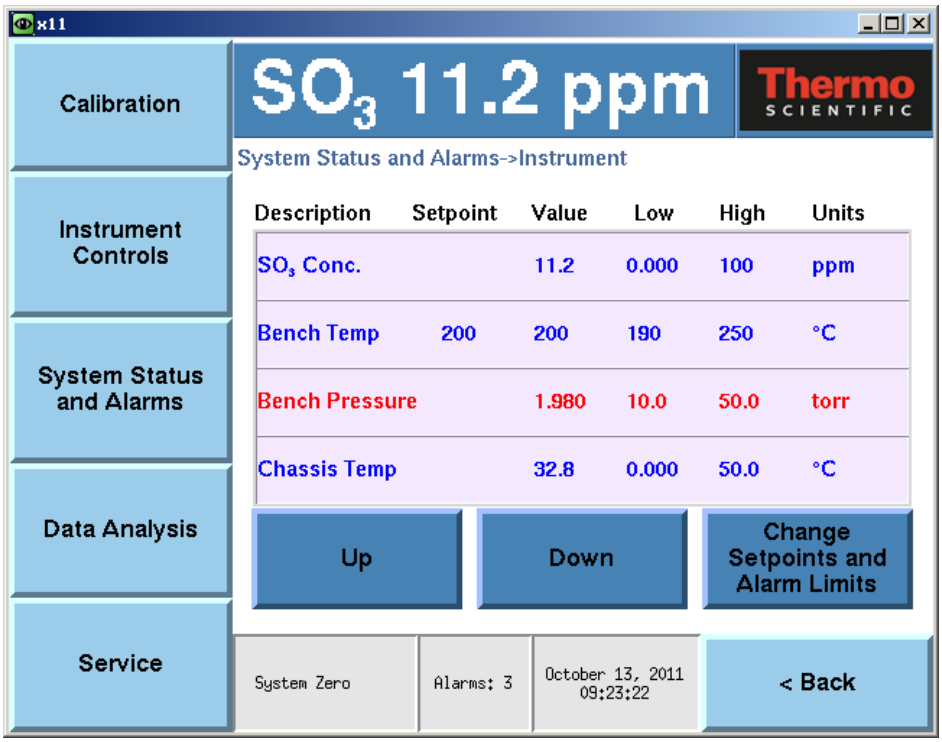


Figure 3–32. Instrument Status Screen

The Instrument Status screen contains the following buttons:

- *Up and Down:* Use the ↑ and ↓ buttons to move the page up and down.
- *Change Setpoints and Alarm Limits:* To change the alarm limits or setpoint values, touch the row to highlight it. Next, press the **Change Setpoints and Alarm Limits** button. This allows the user to change a temperature or pressure setpoint and/or change that specific alarm limit. See "Change Setpoints and Alarm Limits" on page "3-45".

The Instrument Status screen contains the following information:

Table 3–1. System Status—Instrument (shown with default setpoints and alarm limits)

Description	Setpoint	Low	High	Units
SO_3 Conc		0	100	ppm
Bench Temp	220	200	250	°C
Bench Pres		20	50	torr
Chassis Temp		10	50	°C
SO_2 Cal Flow		0.000	0.500	L/min
Span Dil Air Flow		0.000	10.0	L/min
Span Reading		9.50	10.5	ppm
Laser Temp	9	-8	-6	°C
Laser Housing Temp	20	15	25	°C
Laser Voltage		6	8	V
Detector Temp	-50	-65	-55	°C
Detector Peak		-5	5	Channel

Note Information on how to center the SO_3 peak on channel 0, as seen in the Transmission Spectrum screen, can be found in the Service Menu > **Laser Controls** section of this manual. ▲

Probe Status

The Probe Status screen (Figure 3–33) provides information with respect to the probe devices, setpoints, and readings. Real-time values and alarm limits are shown. Alarm limits can be changed. Values that trigger alarms will be shown in red. Temperature and Pressure Setpoints can be viewed and changed.

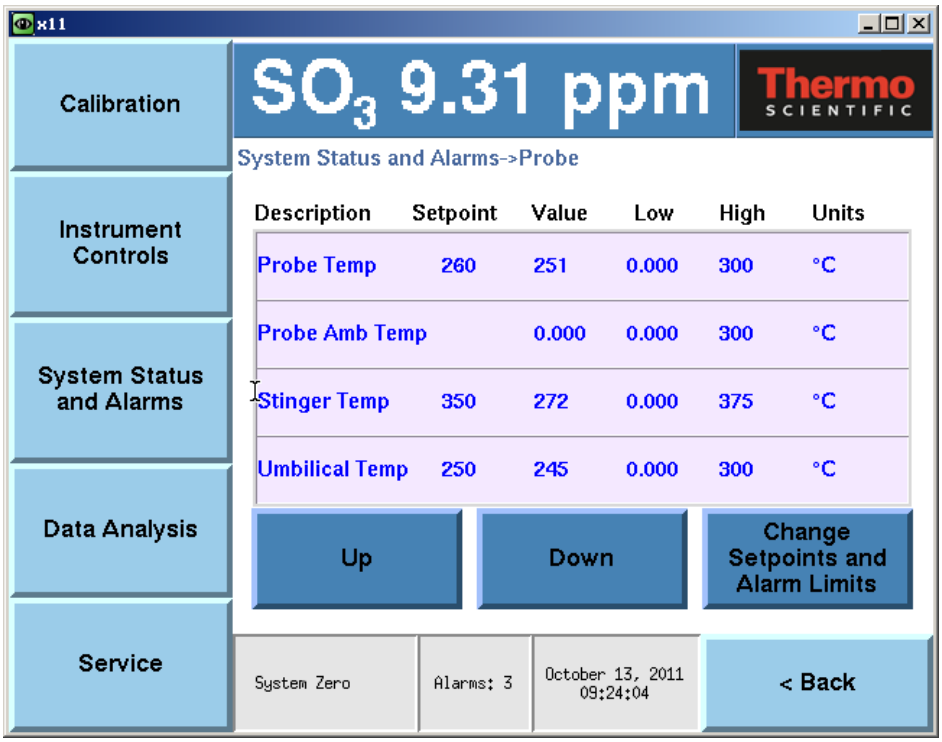


Figure 3–33. Probe Status Screen

The Probe Status screen contains the following buttons:

- *Up and Down:* Use the ↑ and ↓ buttons to move the page up and down.
- *Change Setpoints and Alarm Limits:* To change the alarm limits or setpoint values, touch the row to highlight it. Next, press the **Change Setpoints and Alarm Limits** button. This allows the user to change a temperature or pressure setpoint and/or change that specific alarm limit. See "Change Setpoints and Alarm Limits" on page "3-45".

The Probe Status screen contains the following information:

Table 3–2. System Status—Probe (shown with default setpoints and alarm limits)

Description	Setpoint	Low	High	Units
Probe Temp	275	250	300	°C
Probe Ambient Temp		150	300	°C
Stinger Temp	350	325	375	°C
Umbilical Temp	275	250	300	°C
Umbilical Stitch Temp	250	225	275	°C
Orifice Stitch Temp	300	275	325	°C
Generator Temp	425	400	590	°C
Generator Stitch Temp	300	200	325	°C
Eductor Pres	15	5	50	psi
Dilution Air Pres	45	20	80	psi
Dilution Vacuum		19.0	25.0	in H_2O
Venturi Pressure		0	10	in H_2O

Change Setpoints and Alarm Limits

The Change Setpoints and Alarm Limits screen (Figure 3–34) is used to change temperature and pressure setpoints and set the low and high alarm limits for instrument and probe devices found in System Status and Alarms. Based on which device is selected, the **Setpoint** button allows the user to change the setpoint within a pre-determined range. The **Low** and **High** buttons allow the user to change the alarm limits within a pre-determined range. When the **Setpoint**, **Low** or **High** button is pushed, the numeric keypad comes up.

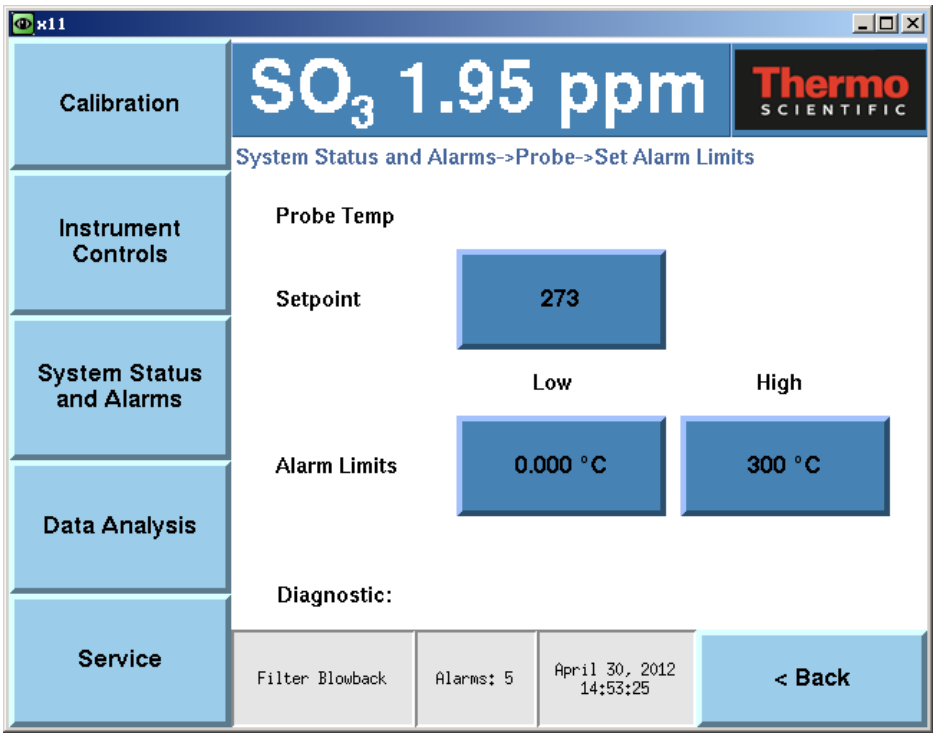


Figure 3–34. Set Alarm Limits Screen

Note Some instrument and probe devices do not have settable setpoints. When this is the case, the setpoint button will read “No Setpoint”. ▲

Board Status

The Board Status screen (Figure 3–35) provides computer board information. If the board is functioning correctly, the status will say "OK". If not, it will say "Fail".

Use the ↑ and ↓ buttons to move the page up and down.

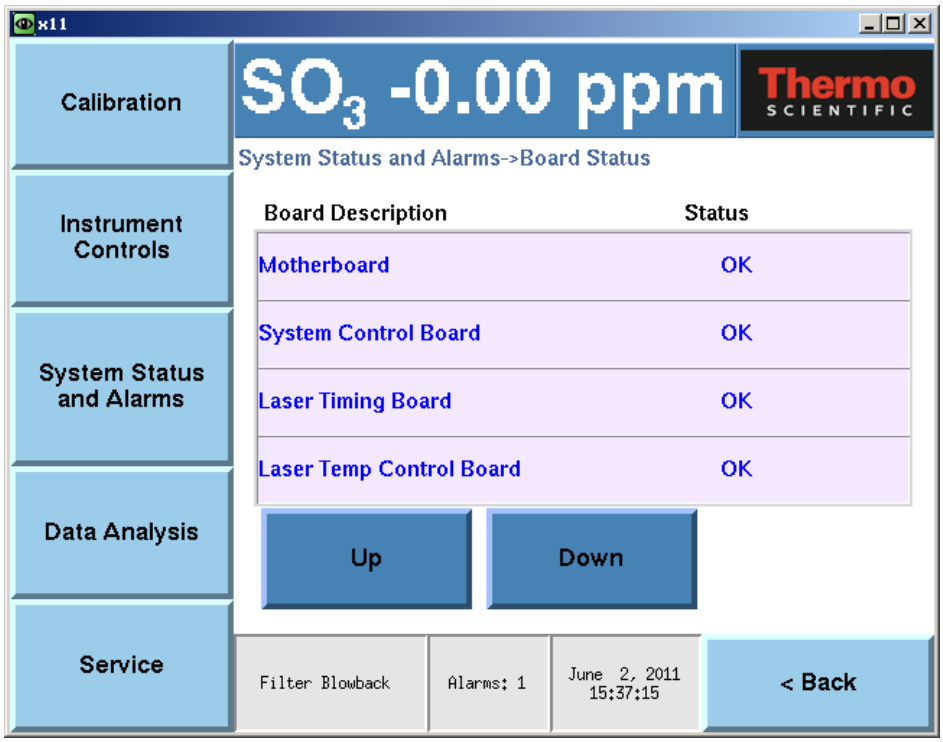


Figure 3–35. Board Status Screen

The Board Status screen contains the following information:

Table 3–3. System Status—Board

Description	Status
Motherboard	OK
System Control Board	OK
Laser Timing Board	OK
Laser Temp Control Board	OK
Laser Housing Temp Control Board	OK
Detector	OK
CPU Board	OK

Voltages

The Voltage screen (Figure 3–36) displays board voltages. This can be useful when diagnosing computer board problems.

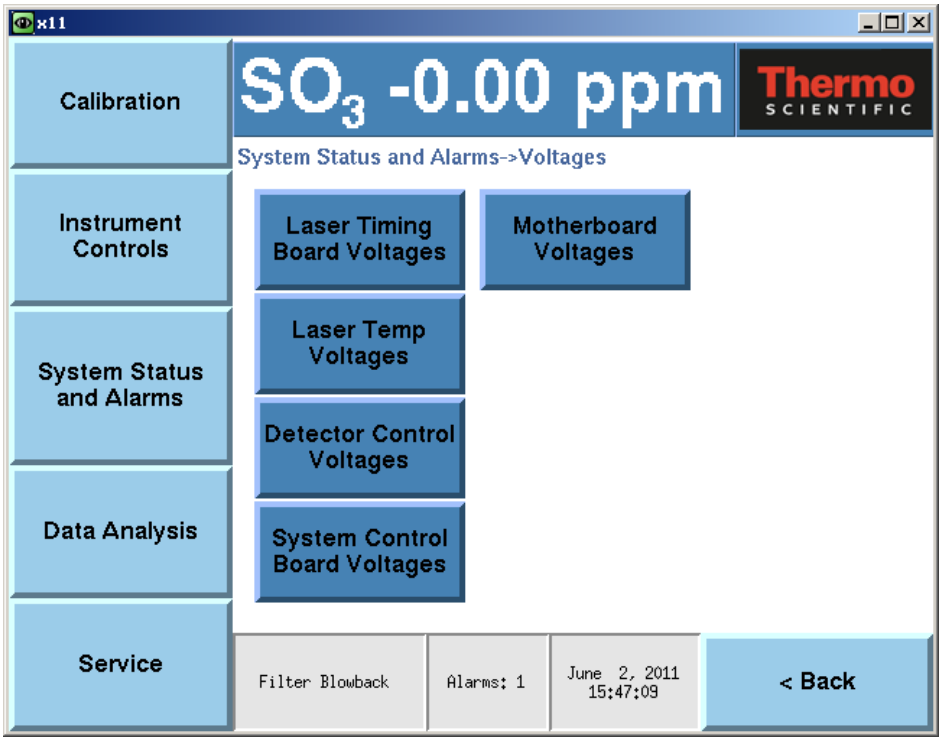


Figure 3–36. Voltages Screen

The Voltage screen contains the following information:

- *Laser Timing Board Voltages*. Displays voltages related to laser timing control.
- *Laser Temp Voltages*. Displays voltages related to laser and laser housing temp control.
- *Detector Control Voltages*. Displays voltages related to detector control.
- *System Control Board Voltages*. Displays voltages related to the system control board.
- *Motherboard Voltages*. Displays voltages related to supply voltages.

Data Analysis Menu

The Data Analysis menu (Figure 3–37) is used to view and record SO_3 concentrations and system data. Various ways of analyzing data are offered including graphing data, data logged lists, real time spectrum and more.

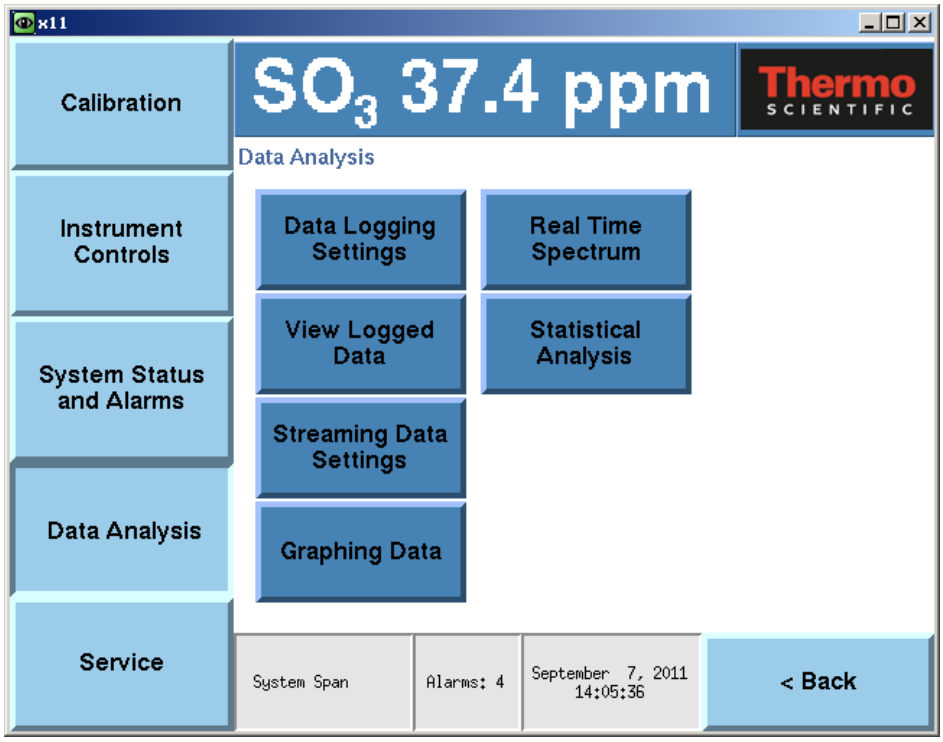


Figure 3–37. Data Analysis Screen

The Data Analysis screen contains the following buttons:

- *Data logging Settings:* User selects the parameters for collecting data.
- *View Logged Data:* User views historical data.
- *Streaming Data Settings:* User can stream data to a computer real time.
- *Graphing Data:* User can graph two sets of data from the information stored in *view logged data*.
- *Real Time Spectrum:* Allows the user to view the current raw spectrum and the transmission spectrum.
- *Statistical Analysis:* The user can view the minimum, maximum, and standard deviation of two items over a specified period of time.

Data Logging Settings

The Data Logging Settings screen (Figure 3–38) allows the user to select data to be stored and how it is stored.

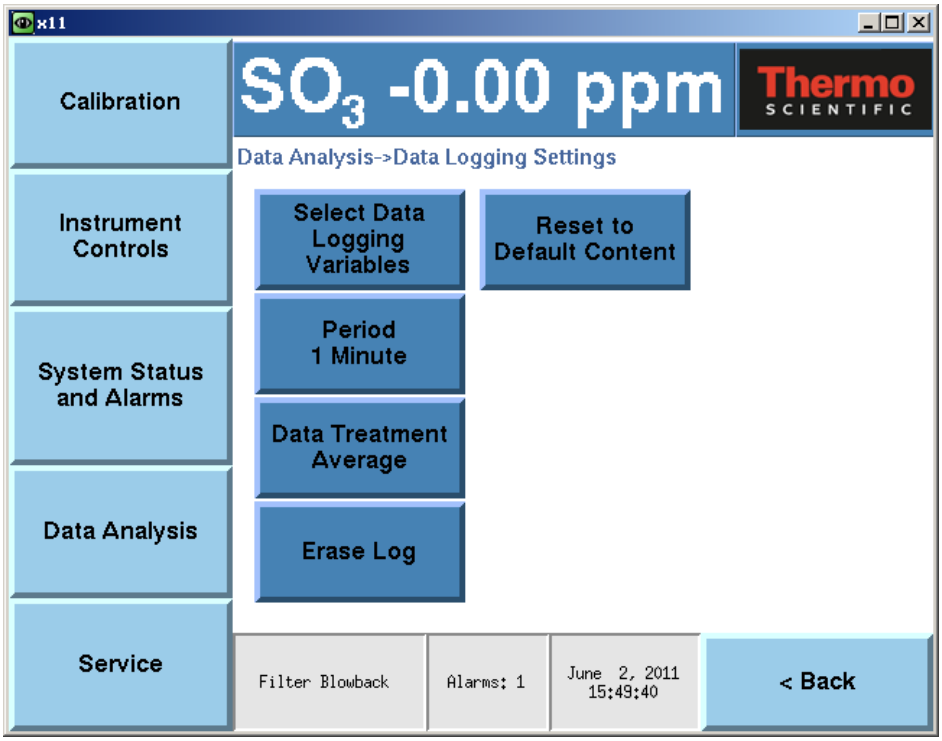


Figure 3–38. Data Logging Screen

The Data Logging screen contains the following information:

- *Select Data Logging Variables*. User selects system variables to log. The following variables are always selected and cannot be disabled: Date/Time, Number of Active Alarms, Alarms Flag, System Gas Mode, and SO_3 Concentration. See "Table 3–4" for data logging variable list. As a default, all variables are selected.
- *Period*. User selects how often data is collected by setting the duration between logged data.
- *Data Treatment*. Toggles between Average, Current, Min and Max. When set to average, the average value during the period will be recorded. When set to current, the latest data will be recorded. When set to min or max, the minimum or maximum value during the period will be recorded. The board status will automatically be set to current, even if averaging is selected.
- *Erase Log*. Allows the user to erase all values in the data log.

- *Reset to Default Content*. Allows the user to reset the default data logging fields.

View Logged Data

The View Logged Data screen (Figure 3–39) allows the user to define which data records to view. Two ways of selecting viewable data are offered—Time Range and Number of records back.

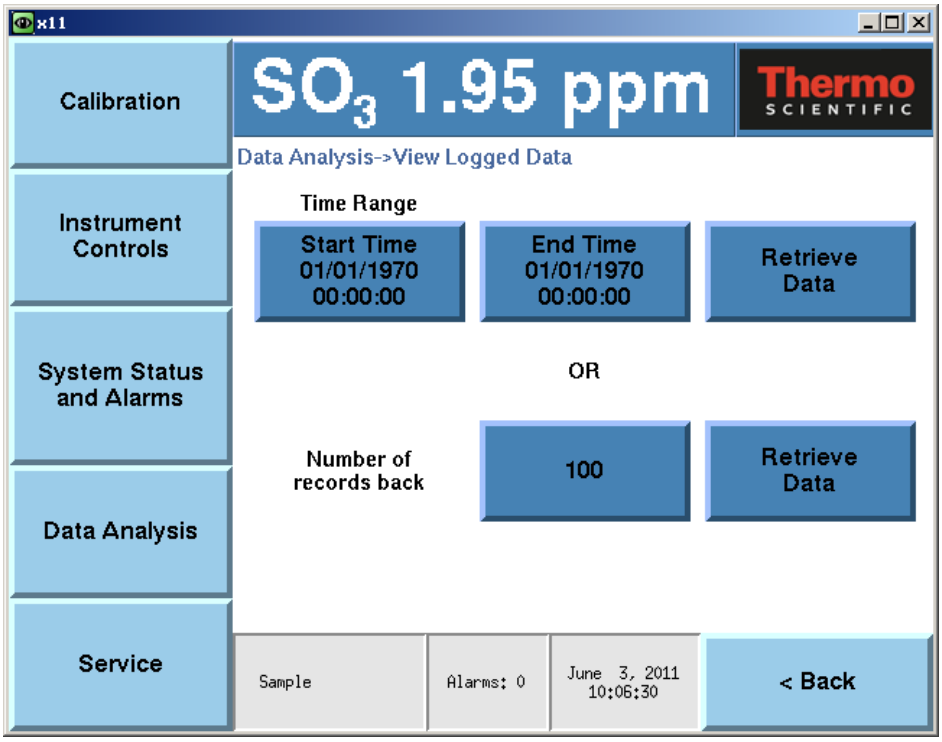


Figure 3–39. View Logged Data Screen

The View Logged Data screen contains the following information.

Time Range Selection:

- *Start/Time*. Start time to retrieve data.
- *End Time*. End time to retrieve data.
- *Retrieve Data (first row)*. Displays data logging values (based on Time Range conditions).

Number of Records Back Selection:

- *Number of Records Back*. Defines data logging retrieval by number of records.
- *Retrieve Data (second row)*. Displays data logging values (based on Number of records back).

Data Logging Retrieve Data

The Retrieve Data screen (Figure 3–40) displays data logging values based on time conditions or number of records. The most recent records are located at the bottom. Single column scrolling can be done Left-Right. Single or page scrolling can be done Up-Down.

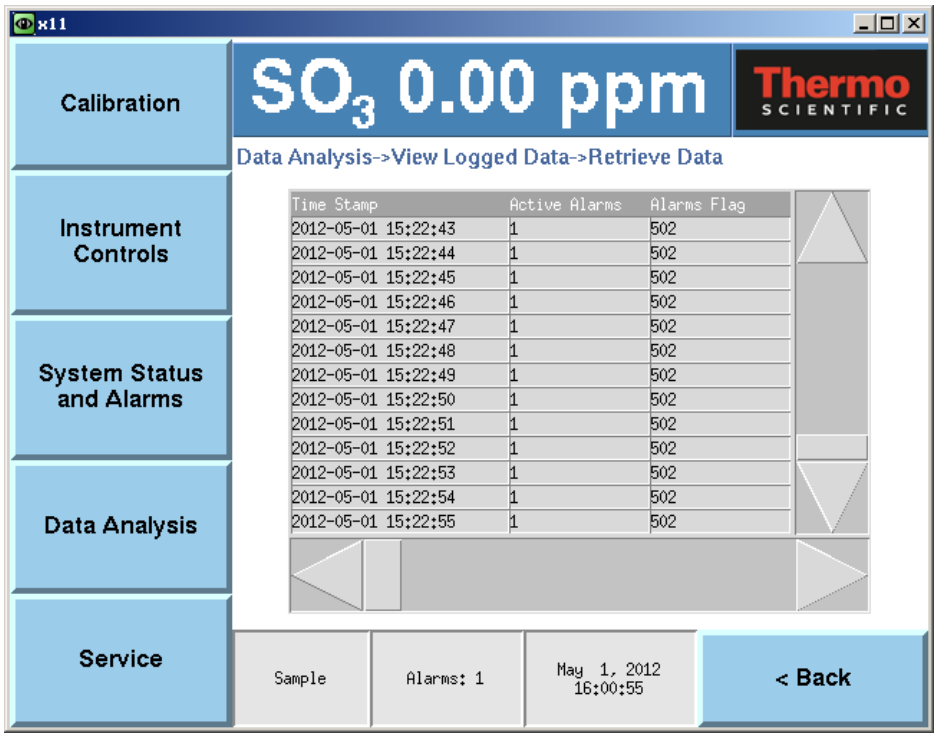


Figure 3–40. Retrieve Data Screen

Streaming Data Settings

The Streaming Data Settings screen (Figure 3–41) allows the user to stream data to a computer.

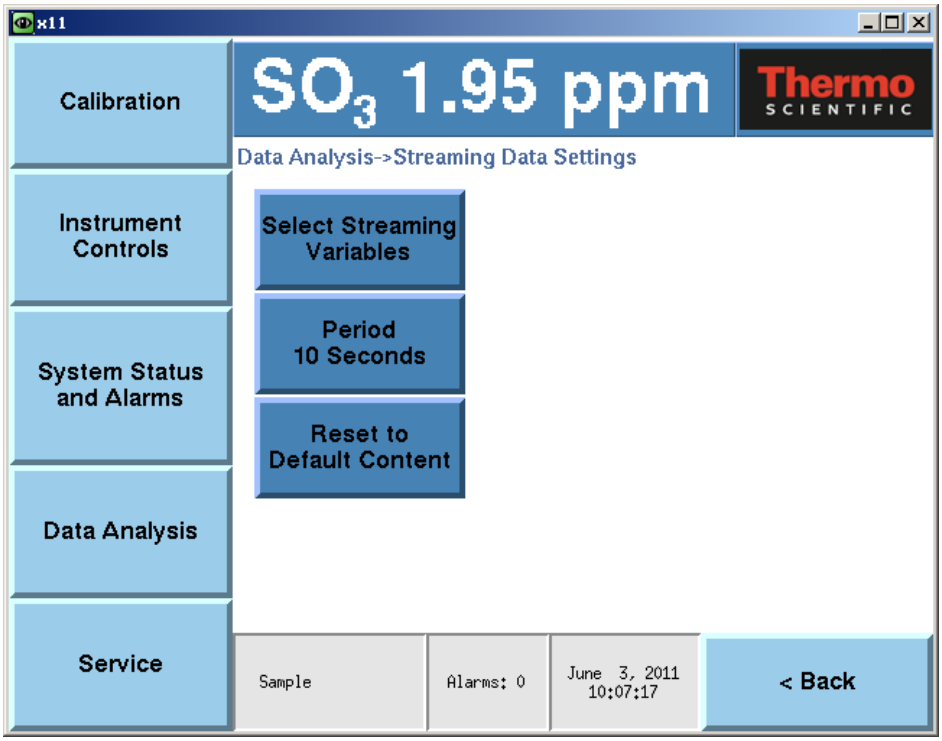


Figure 3–41. Streaming Data Settings Screen

The Streaming Data screen contains the following information:

- *Select Streaming Variables*. User selects which variables to stream. "Table 3–4" for streaming variable list. The first 5 variables are always selected and cannot be disabled.
- *Period*. Sets the time between streamed data.
- *Reset to Default Content*. Resets default streaming conditions.

Note When streaming over RS-232 or RS-485, the setting at menu Instrument Controls > Communication Settings > Serial Setting > **Comm Protocol** needs to be set to Streaming. ▲

Data Logging and Streaming Variable Selection

The Select Data Logging Variables screen and the Select Streaming Variables screen (Figure 3–42) allows the user to select which variables to track. The Data logging and Streaming variable lists are **exclusive** from each other but contain the same variable selections.

Use the ↑ and ↓ buttons to select the variable. Next, press the **Commit Changes** button. Yellow buttons indicate that the variable is selected.

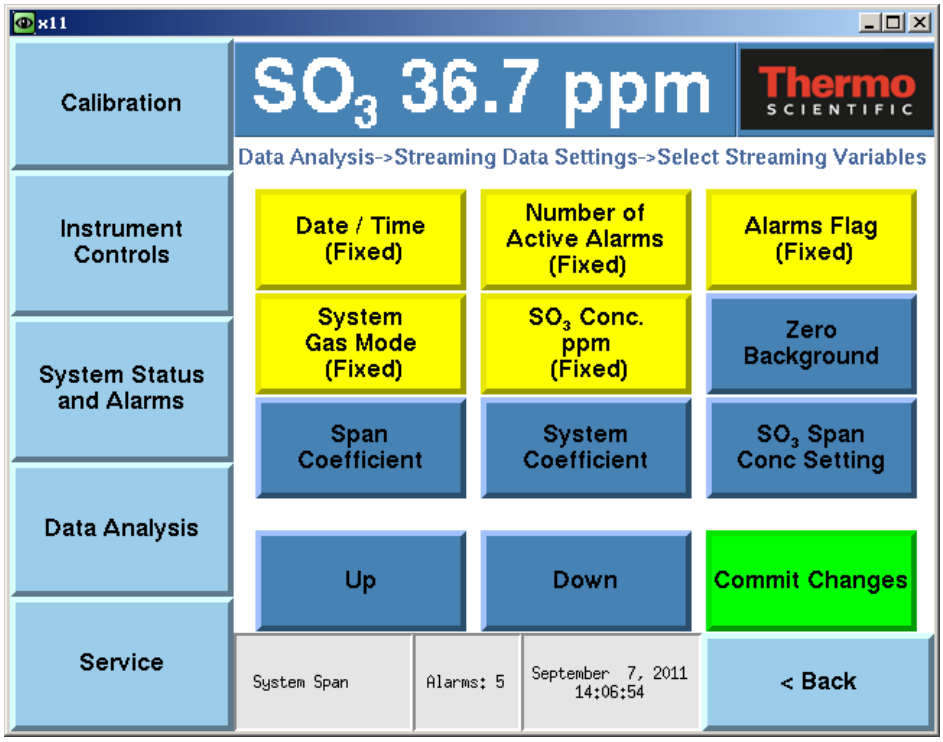


Figure 3–42. Variable

Table 3–4 contains the variables that can be selected for Data logging:

Table 3–4. Variable List for Data Logging and Streaming

Instrument
Date/Time (fixed)
Number of Action Alarms (fixed)
Alarms flag (fixed)
System Gas Mode (fixed)
SO_3 Conc. ppm (fixed)
Zero Background
Span Coefficient

Instrument
System Coefficient
SO_3 Span Conc. Setting
SO_3 Span Conc. Reading
Span Flow
Span Dilution Air Flow
Bench Temp
Bench Pressure
Laser Voltage
Laser Temp
Laser Housing Temp
Detector Temp
Detector Peak Signal
Chassis Temp
Probe
Probe Temp
Probe Ambient Temp
Stinger Temp
SO_3 Generator Temp
SO_3 Generator Stitch Temp
Orifice Stitch Temp
Umbilical Temp
Umbilical Stitch Temp
Eductor Pressure
Dilution Pressure
Venturi Pressure
Dilution Vacuum
System Status
Motherboard Status
System Control Board Status
Laser Board Status
Laser Temp Board Status
Laser Housing Board Status
Detector Board Status
CPU Board Status

Graphing Data

The Graphing Data screen (Figure 3–43) allows the user to choose one or two variables to graph. The data is taken from the data logging records. Only the variables that are currently selected for data logging will appear.

Use the ↑ and ↓ buttons to select the variable. Next, press the **Commit & View Graph** button. Yellow indicates that the variable is selected.

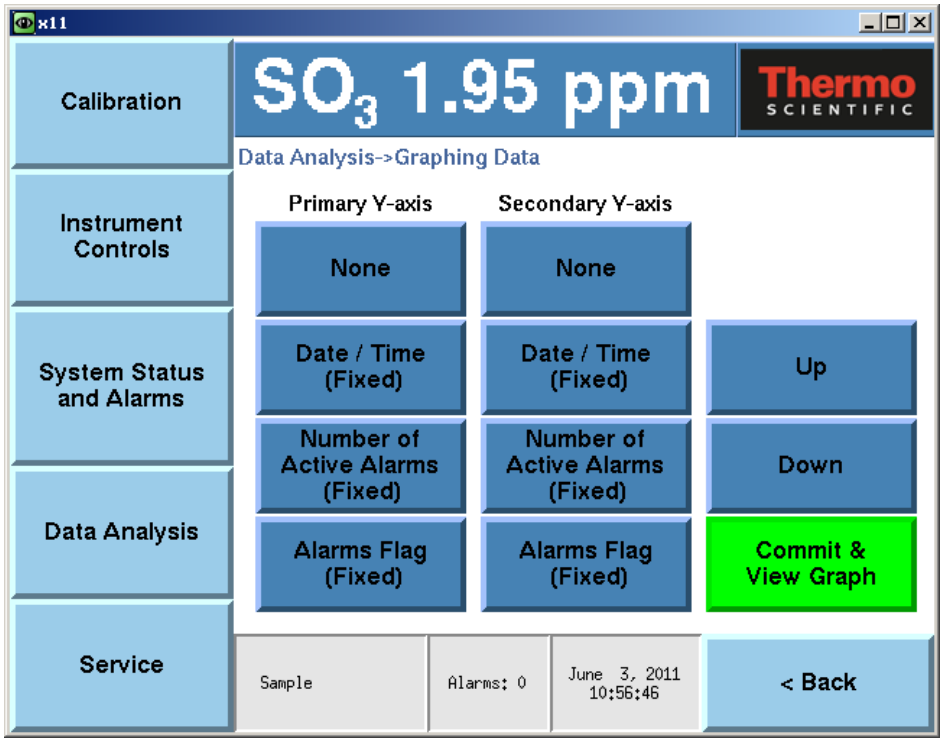


Figure 3–43. Graphing Data Screen

The Graphing Data screen contains the following information:

- *Primary Y-axis*. Variable data will be associated with the left y-axis.
- *Secondary Y-axis*. Variable data will be associated with the right y-axis.
- *Commit & View Graph*. Graph is displayed.

Note Graphic data is taken from the data logging records. The list of available variables from the Graphing Data screen reflects the highlighted variables in the data logging variable list. ▲

View Graph

The View Graph screen (Figure 3–44) shows the data selected over the selected time period. The left (blue) y-axis pertains to the blue curve while the right (red) y-axis pertains to the red curve.

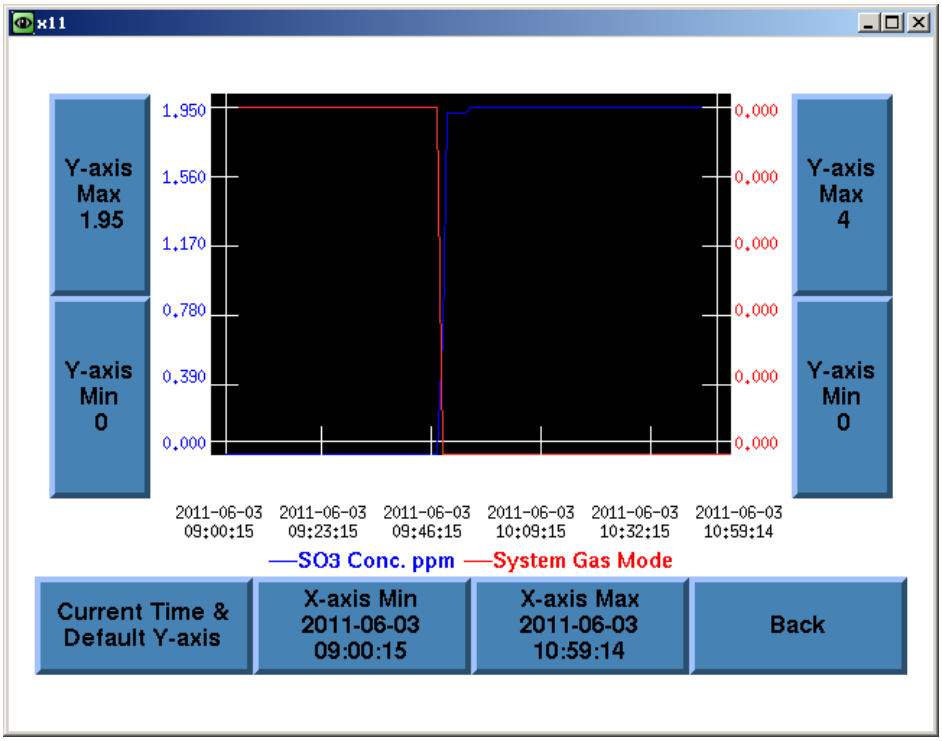


Figure 3–44. View Graph Screen

The Retrieve Data screen contains the following information:

- *Y-axis Max*. Sets the maximum value for the primary y-axis (left) or secondary y-axis (right).
- *Y-axis Min*. Sets the minimum value for the primary y-axis (left) or secondary y-axis (right).
- *X-axis Min*. Sets the minimum value for the x-axis.
- *X-axis Max*. Sets the maximum value for the x-axis.
- *Current Time &Default Y-axis* . Auto scales the primary and secondary y-axis and sets the x-axis to the last 2 hours.

Real Time Spectrum

The Real Time Spectrum screen (Figure 3–45) allows the user to look at current spectrum.

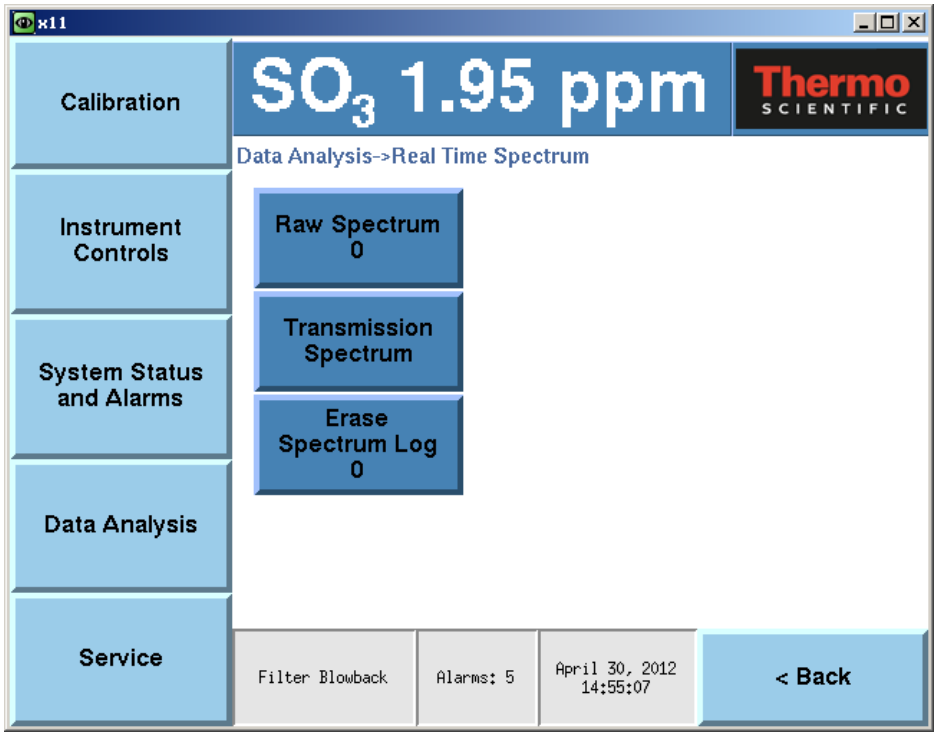


Figure 3–45. Real Time Spectrum Screen

The Real Time Spectrum screen contains the following information:

- *Raw Spectrum*. Displays the latest spectrum from the detector.
- *Transmission Spectrum*. Displays the latest SO_3 transmission spectrum (taken from the raw spectrum) and also the voigt fit.
- *Erase Spectrum Log*. Shows the number of backlogged spectrums. When the user presses the Erase Spectrum Log button, the backlogged spectrums will be erased. Responds with “Are you sure?” and requires a Yes or No action.

Raw Spectrum

The Raw Spectrum screen (Figure 3–46) allows the user to view the raw spectrum from the detector board. The y-axis is intensity of signal and the x-axis is channel numbers. The blue curve is the signal received from the detector and the red curve is the polynomial fit (baseline) associated with a portion of the blue curve.

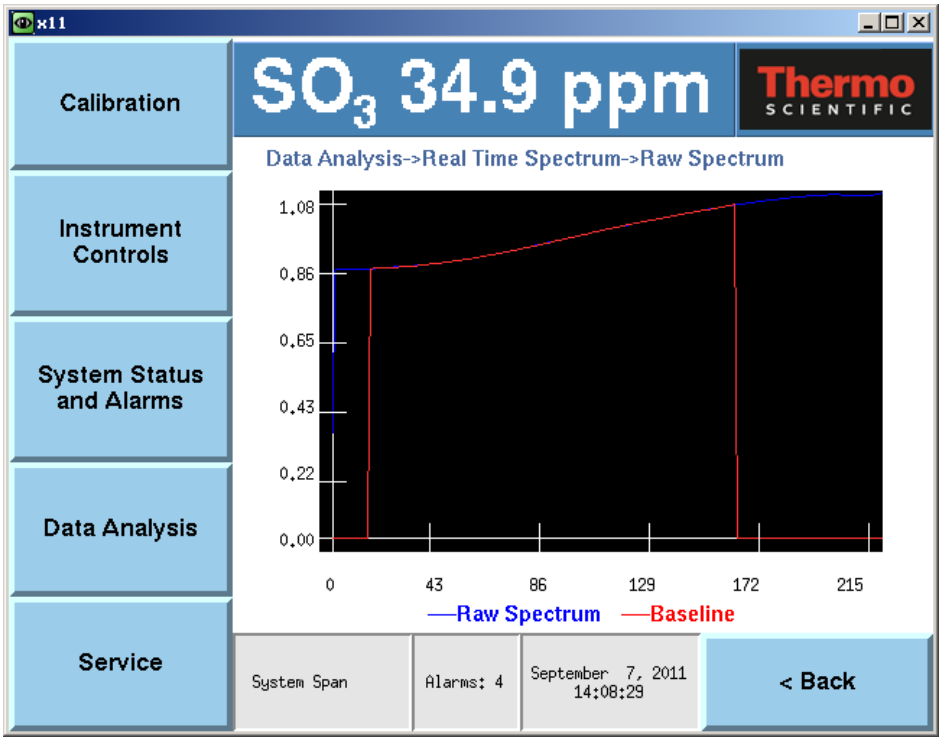


Figure 3–46. Raw Spectrum Screen

Note The intensity of the blue signal curve should be greater than 0.30. If not, the laser voltage may need to be increased but should not exceed 9 volts. Also, detector and/or laser alignment may be needed. ▲

Transmission Spectrum

The Transmission Spectrum screen (Figure 3–47) shows the SO_3 transmission spectrum, blue curve. The red curve is the voight fit, which is used to measure the strength of the SO_3 signal resulting in a concentration.

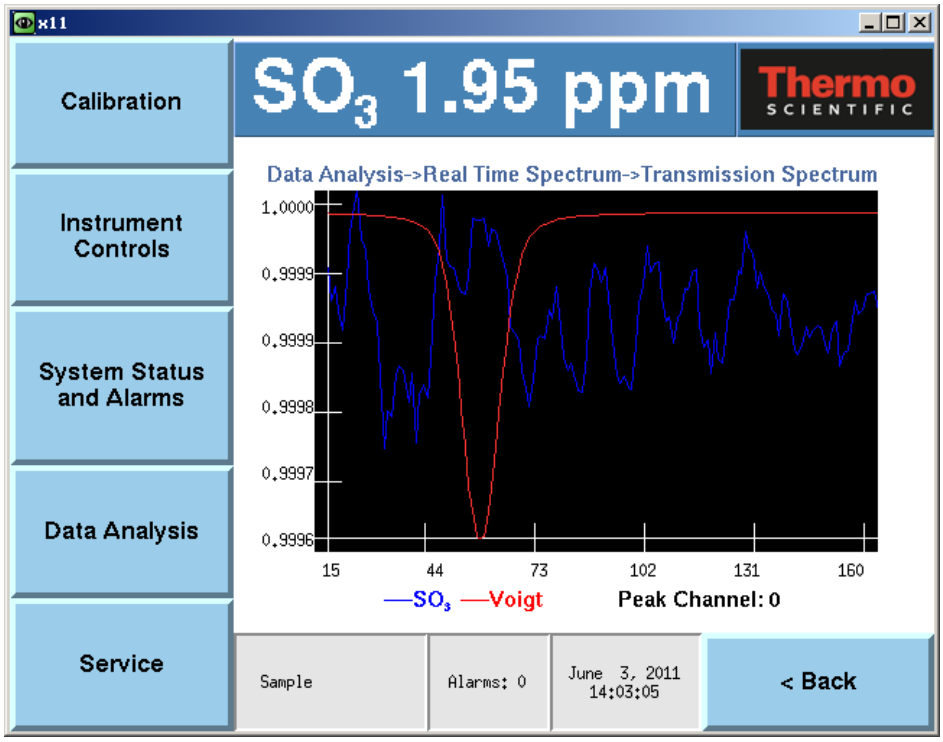


Figure 3–47. Transmission Spectrum Screen

The peak channel number correlates to where the SO_3 signal is located within the chart. The SO_3 signal peak should fall within channels -5 to 5. If it falls outside that range, especially during calibration, the laser temperature should be adjusted (see Laser Controls in the Service section).

If the peak channel displays 20, then the lowest peak within channels -10 to 10 is above 0.9995. In this case, the SO_3 signal is weak and the voigt fit (red curve) will be centered at channel 0. This might occur during zero and sample mode.

Erase Spectrum Log

The Erase Spectrum Log (Figure 3–48) erases all pending spectrum logs. User should not have to use this feature unless the spectrum log gets backed up.

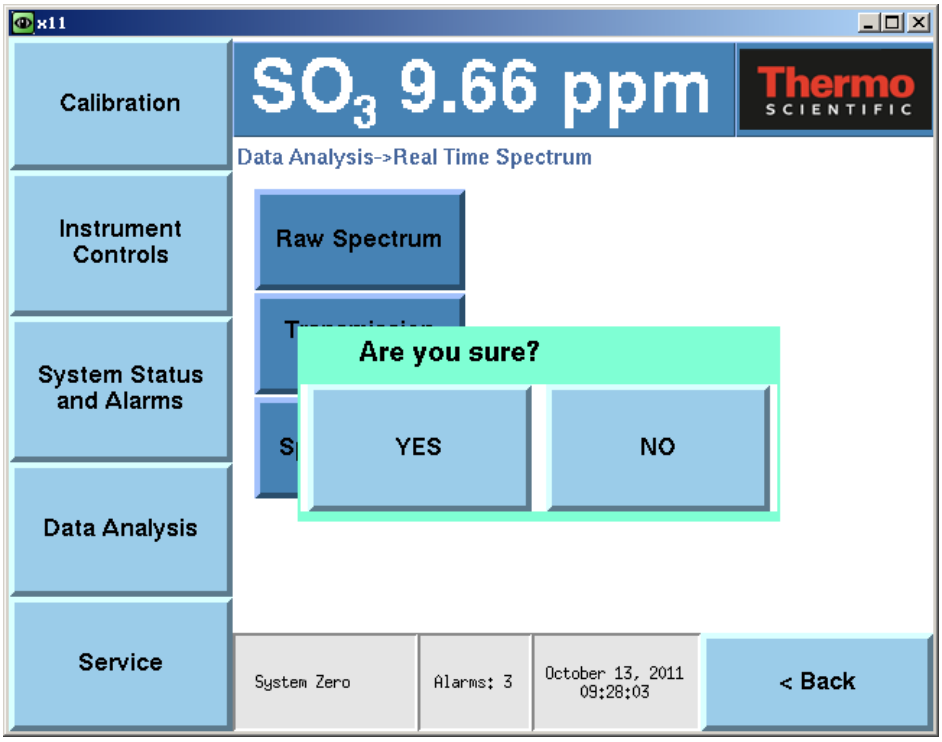


Figure 3–48. Erase Spectrum Log Screen

Statistical Analysis

The Statistical Analysis screen (Figure 3–49) provides statistical data for SO_3 concentration and system devices. This information is pulled from the information found in data logging. Therefore, only the variables currently selected in the data logging menu will be available for statistical analysis. The minimum, maximum, and standard deviation values for each variable are displayed.

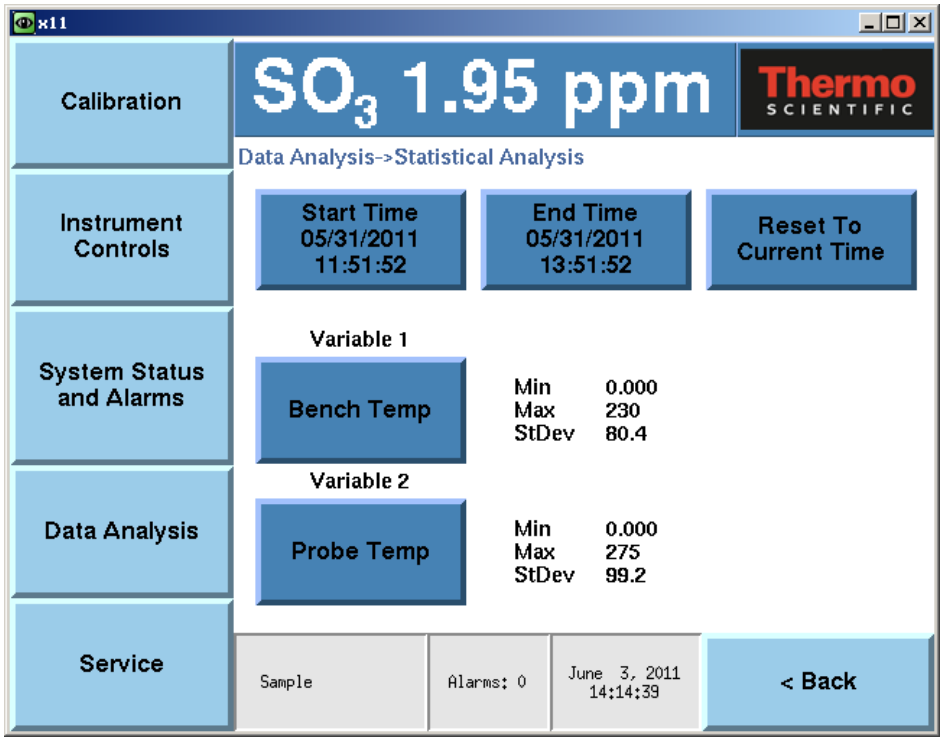


Figure 3–49. Statistical Analysis Screen

The Statistical Analysis screen contains the following information:

- *Start Time*. The beginning of the period under analysis.
- *End Time*. The end of the period under analysis.
- *Reset to Current Time*. Sets the time period to the last two hours.
- *Select Variable 1*. User selects variable from list that has been selected in data logging.
- *Select Variable 2*. User selects variable from list that has been selected in data logging.

Service Menu

The Service Menu (Figure 3–50) allows the user to set and control various system devices. The Service menu will be locked out if password protection (located in the Instrument Controls menu) is enabled.

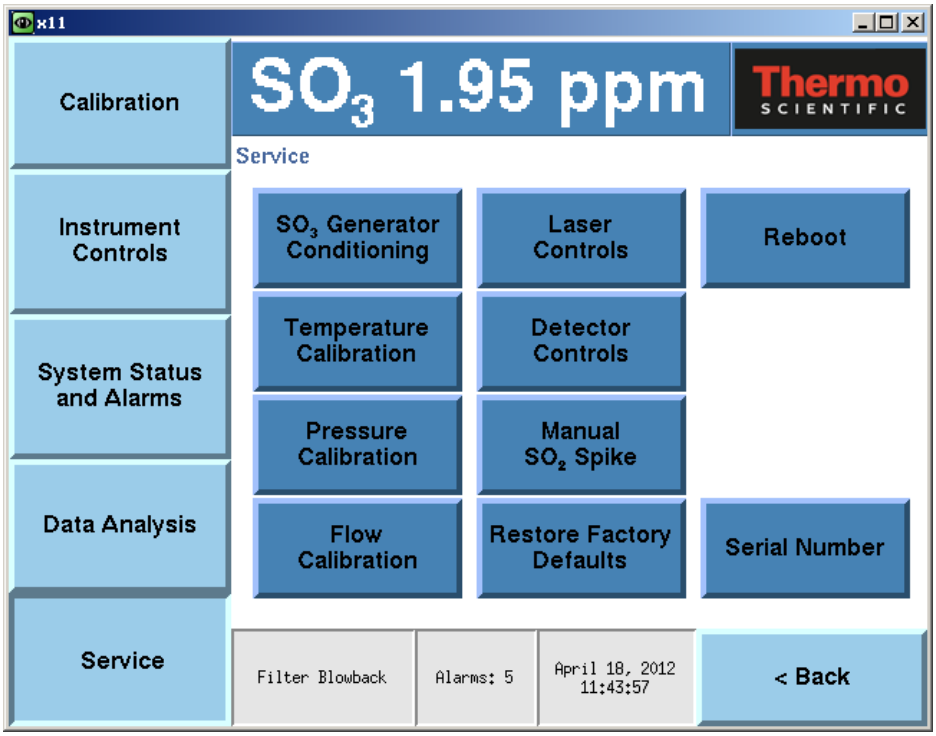


Figure 3–50. Service Screen

The Service Menu contains the following information:

- *SO_3 Generator Conditioning:* User can schedule periodic maintenance for the SO_3 generator.
- *Temperature Calibration:* User can calibrate temperature readings.
- *Pressure Calibration:* User can calibrate pressure readings.
- *Flow Calibration:* User can calibrate flow readings.
- *Laser Controls:* User can set laser control parameters.
- *Detector Controls:* User can set detector control parameters.
- *Manual SO_2 Spike:* The SO_2 flow will bypass the SO_3 generator.
- *Restore Factory Defaults:* All system factory defaults will be restored.
- *Reboot:* Instrument will reboot or shutdown.

SO_3 Generator Conditioning

The SO_3 Generator Conditioning screen (Figure 3–51) is used to periodically and automatically clean the SO_3 generator catalyst. It is recommended to condition the SO_3 generator at 580 °C for 60 minutes at least once a week.

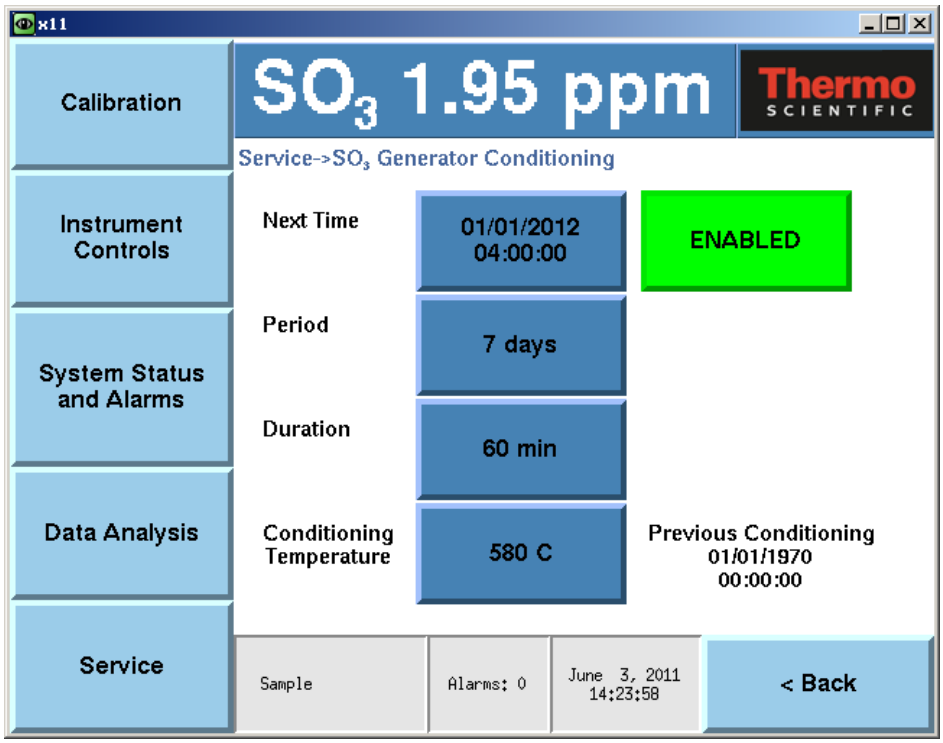


Figure 3–51. SO_3 Generator Conditioning Screen

The SO_3 Generator Conditioning screen contains the following information:

- *Enable/Disable*. Turns the generator conditioning schedule ON/OFF.
- *Next Time*. Sets the next scheduled event for generator conditioning.
- *Period*. The time in between conditioning events.
- *Duration*. Sets how long the conditioning event will run.
- *Conditioning Temp*. The temperature of the generator during a conditioning event.
- *Previous*. Displays the last time the generator conditioning was run.

Temperature Calibration

The Temperature Calibration menu (Figure 3–52) is used to calibrate instrument and probe thermocouple and thermistors. Most likely no calibration will be needed and the coefficient can be left at 1.000.

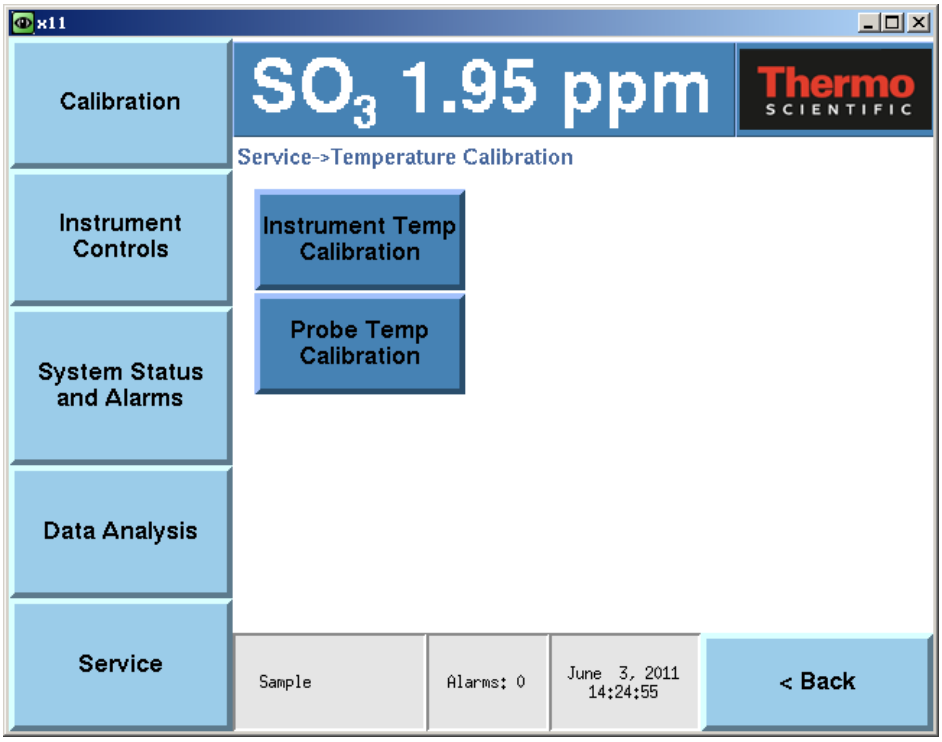


Figure 3–52. Temperature Calibration Screen

The Temperature Calibration screen contains the following information:

- *Instrument Temp Calibrations*. Menu for calibrating instrument temperature readings.
- *Probe Temp Calibrations*. Menu for calibrating probe temperature readings.

Instrument Temp Calibrations

The Instrument Temp Calibrations screen (Figure 3–53) is used to calibrate instrument thermocouples and thermistors.

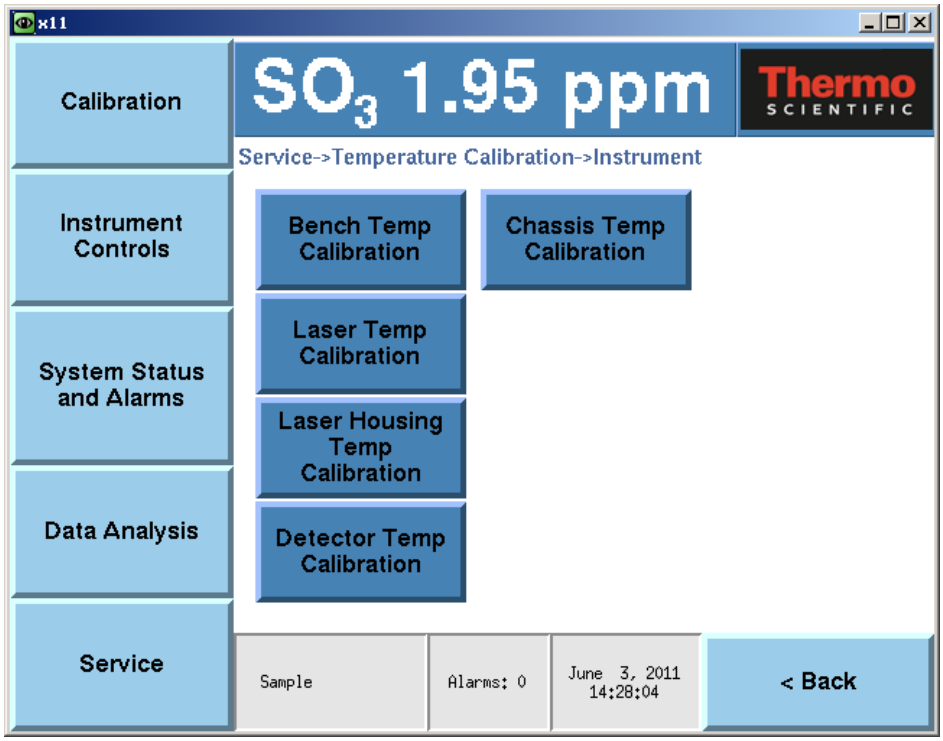


Figure 3–53. Instrument Temp Calibrations Screen

The Instrument Temp Calibrations screen allows the user to calibrate the following temperature readings:

- *Bench Temp Calibration*. Calibrates the optical bench temperature.
- *Laser Temp Calibration*. Calibrates the laser temperature.
- *Laser Housing Temp Calibration*. Calibrates the laser housing temperature.
- *Detector Temp Calibration*. Calibrates the detector temperature.
- *Chassis Temp Calibration*. Calibrates the instrument chassis temperature.

See Figure 3–55 for Temp Calibration example.

Probe Temp Calibration

The Probe Temp Calibration screen (Figure 3–54) is used to calibrate probe thermocouples.

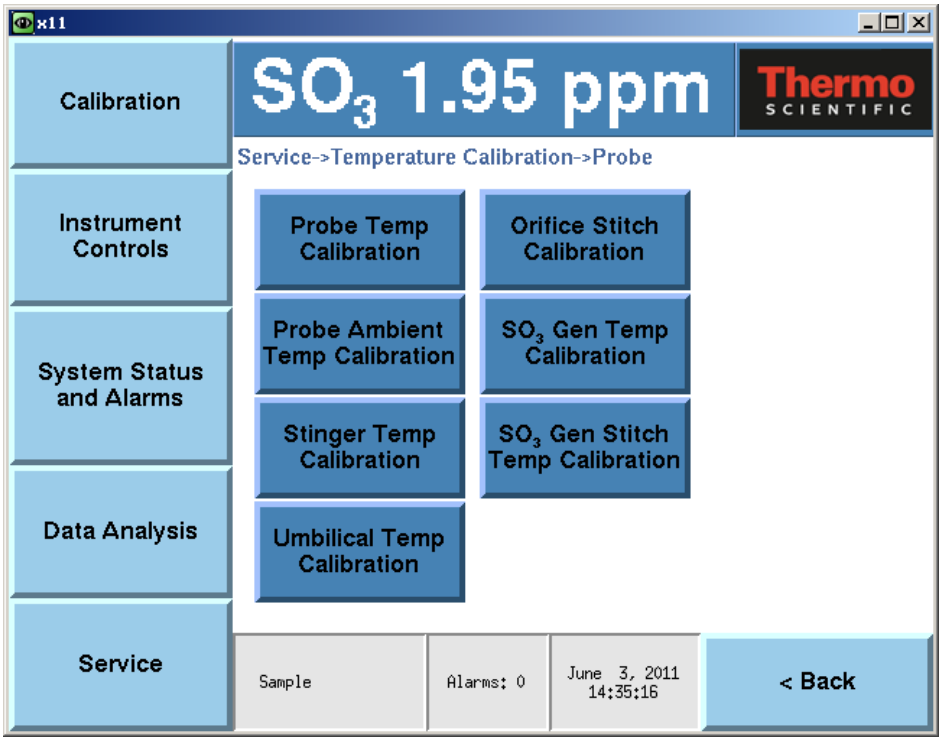


Figure 3–54. Probe Temp Calibrations Screen

The Probe Temp Calibrations allows the user to calibrate the following temperature readings:

- *Probe Temp Calibration*. Calibrates the probe clam shell block temperature.
- *Probe Ambient Temp Calibration*. Calibrates the probe ambient temperature.
- *Stinger Temp Calibration*. Calibrates the stinger temperature.
- *Umbilical Temp Calibration*. Calibrates the umbilical line temperature.
- *Umbilical Stitch Temp Calibration*. Calibrates the umbilical stitch temperature.
- *Orifice Stitch Temp Calibration*. Calibrates the probe orifice stitch temperature.
- *SO_3 Generator Temp Calibration*. Calibrates the SO_3 generator temperature.

- *SO_3 Generator Stitch Temp Calibration*. Calibrates the SO_3 generator stitch temperature.

See Figure 3–55 for Temp Calibration example.

Temp Calibration Example

The Temp Calibration screens (Figure 3–55) are used to calibrate temperature devices. Most likely no calibration will be needed and the coefficient can be left at 1.000.

All temperature calibration screens function the same way. This would include Bench Temp Calibration, Laser Temp Calibration, Laser Housing Temp Calibration, Detector Temp Calibration, Chassis Temp Calibration, Probe Temp Calibration, Probe Ambient Temp Calibration, Stinger Temp Calibration, Umbilical Temp Calibration, Umbilical Stitch Temp Calibration, Orifice Stitch Temp Calibration, SO_3 Generator Temp Calibration, and SO_3 Generator Stitch Temp Calibration screens.

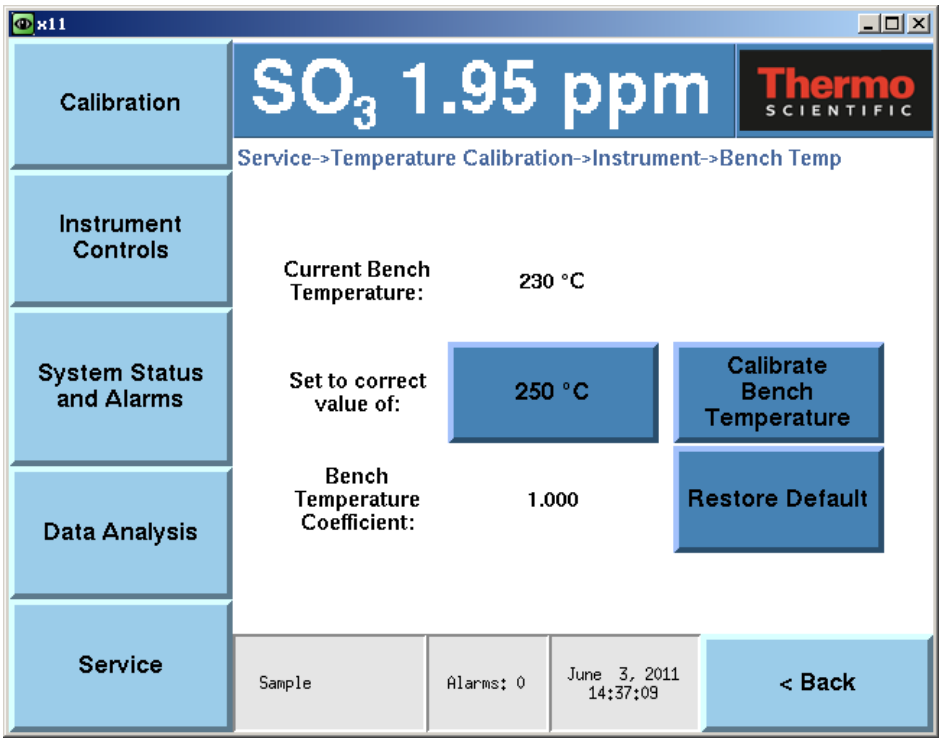


Figure 3–55. Bench Temp Calibrations Screen

The Bench Temp Calibrations screen contains the following information:

- *Current Bench Temperature*. Displays current bench temperature.
- *Set to correct value of*. Using a calibrated thermocouple reader, or similar device, the user measures the bench temperature coming from the thermocouple and enters the correct temperature value using the keypad.

- *Calibrate Bench Temperature*. Based on the current temperature and correct value entered by the user, this button adjusts the temperature coefficient thus calibrating the current bench temperature reading.
- *Bench Temperature Coefficient*. This temperature coefficient value is the result of pressing the Calibrate Bench Temperature button. This coefficient will be applied to the raw temperature value coming from the board.
- *Restore Defaults*. When pressed, the coefficient will be set to 1.000. The displayed temperature will equal the raw temperature coming from the board.

Pressure Calibration

The Pressure Calibration screen (Figure 3–56) is used to calibrate probe pressure regulators, and the bench vacuum gauge.

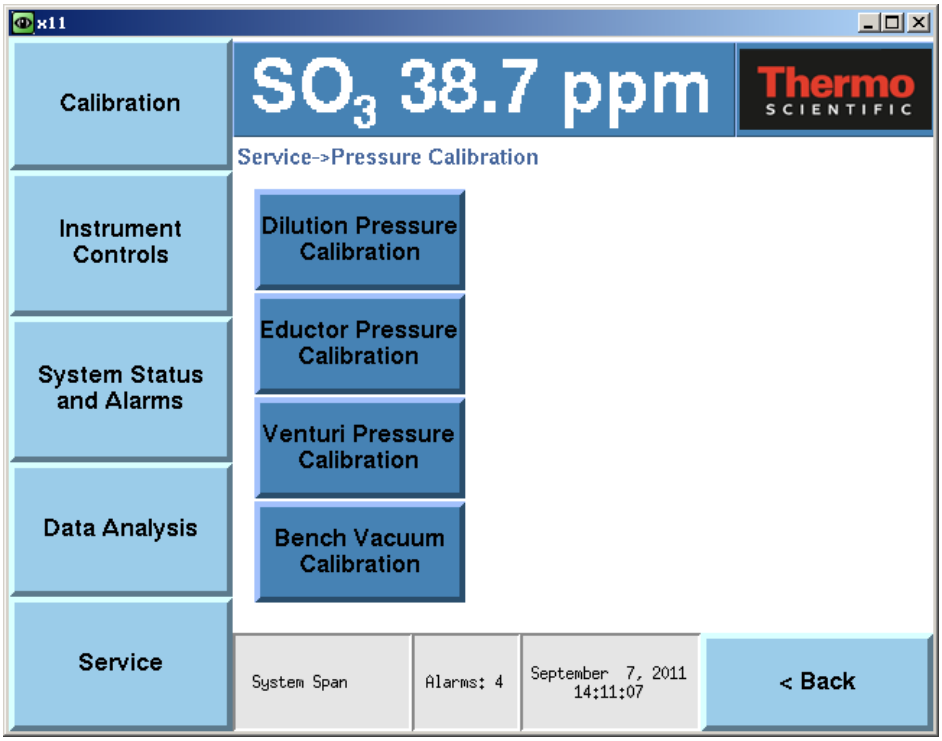


Figure 3–56. Pressure Calibration Screen

The Pressure Calibration screen allows the user to calibrate the following pressure readings:

- *Dilution Pressure Calibration*. Calibrate the probe dilution pressure.
- *Eductor Pressure Calibration*. Calibrate the eductor pressure.
- *Venturi Pressure Calibration*. Calibrate the Venturi pressure.
- *Bench Vacuum Calibration*. Calibrate the optical bench vacuum pressure.

Pressure Calibration Example

The Pressure Calibration screens (Figure 3–57) are used to calibrate pressure devices. Most likely no calibration will be needed and the coefficient can be left at 1.000.

All pressure calibration screens function the same way. This would include Dilution Pressure Calibration, Eductor Pressure Calibration, Venturi Pressure Calibration, and Bench Vacuum Calibration screens.

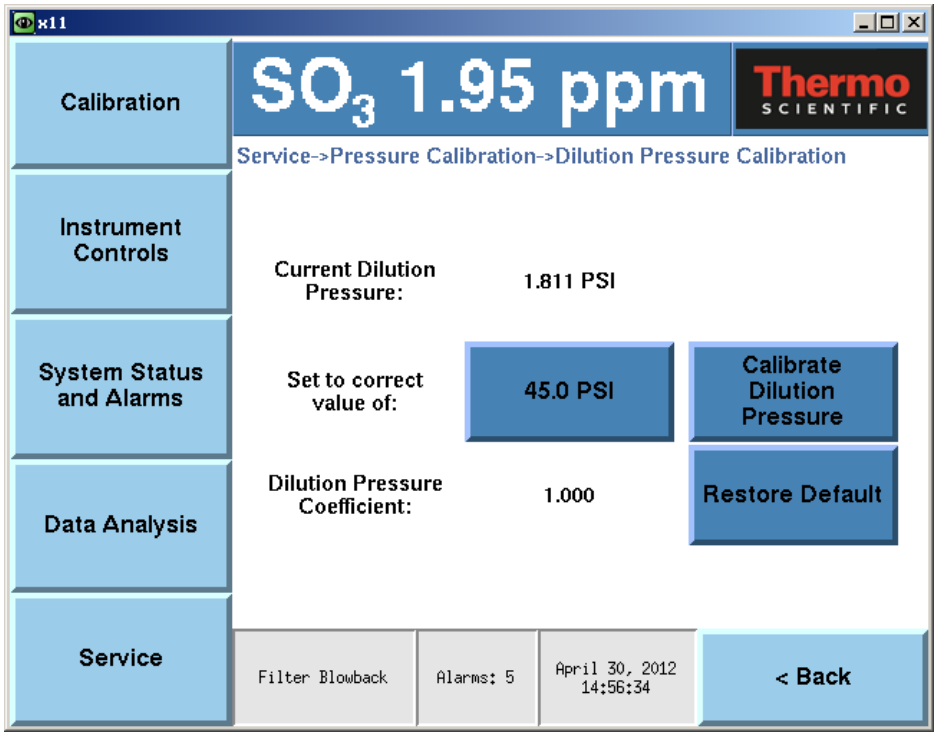


Figure 3–57. Dilution Pressure Calibration Screen

The Dilution Pressure Calibration screen contains the following information:

- *Current Dilution Pressure*. Displays current dilution pressure.
- *Set to correct value of*. Using a calibrated pressure gauge, the user measures the pressure at the spot where the dilution pressure gauge is connected. The user then enters the correct pressure value using the keypad.
- *Calibrate Dilution Pressure*. Based on the current pressure and correct value entered by the user, this button adjusts the pressure coefficient thus calibrating the current dilution pressure reading.
- *Dilution Pressure Coefficient*. This dilution pressure coefficient value is the result of pressing the Calibrate Dilution Pressure button. This

coefficient will be applied to the raw pressure value coming from the board.

- *Restore Defaults*. When pressed, the coefficient will be set to 1.000. The displayed pressure will equal the raw pressure coming from the board.

Flow Calibration

The Flow Calibration screen (Figure 3–58) is used to calibrate the mass flow controllers (MFC's). The MFC's control the SO_2 flow and span dilution air flow during calibration.

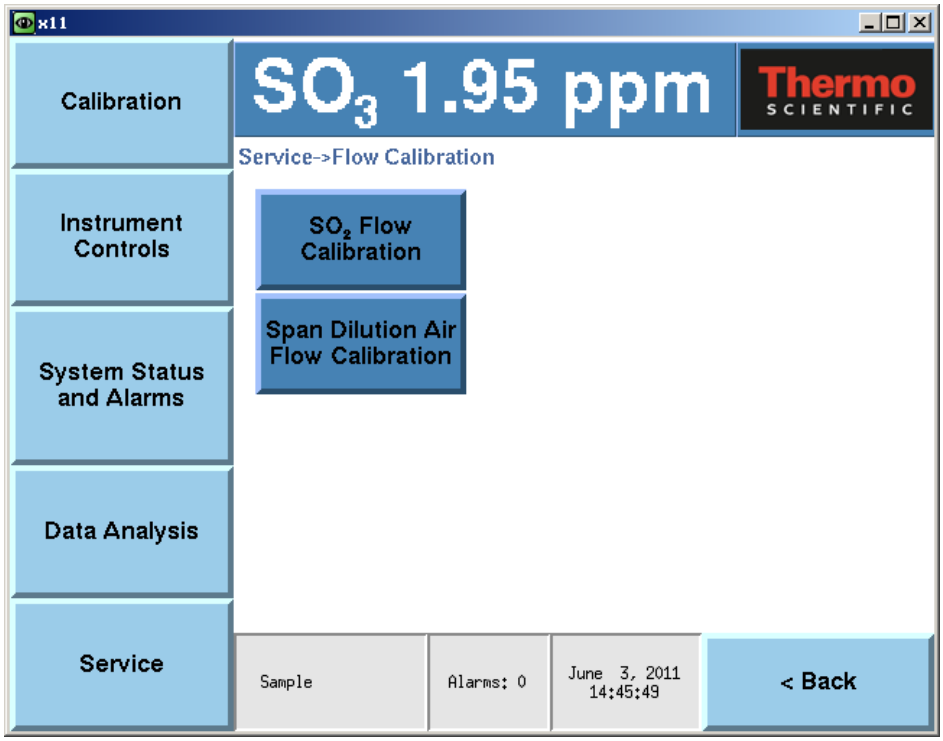


Figure 3–58. Flow Calibration Screen

The Flow Calibration screen allows the user to calibrate the following flows:

- *SO_2 Flow Calibration*. Calibrate the SO_2 flow going to the SO_3 generator.
- *Span Dilution Air Flow Calibration*. Calibrate the span dilution air flow.

Flow Calibration Example

The Flow Calibration screens (Figure 3–59) are used to calibrate MFC's used during calibrations. Most likely no calibration will be needed and the coefficient can be left at 1.000.

The SO_2 Flow Calibration and the Span Dilution Air Flow Calibration screens function the same way.

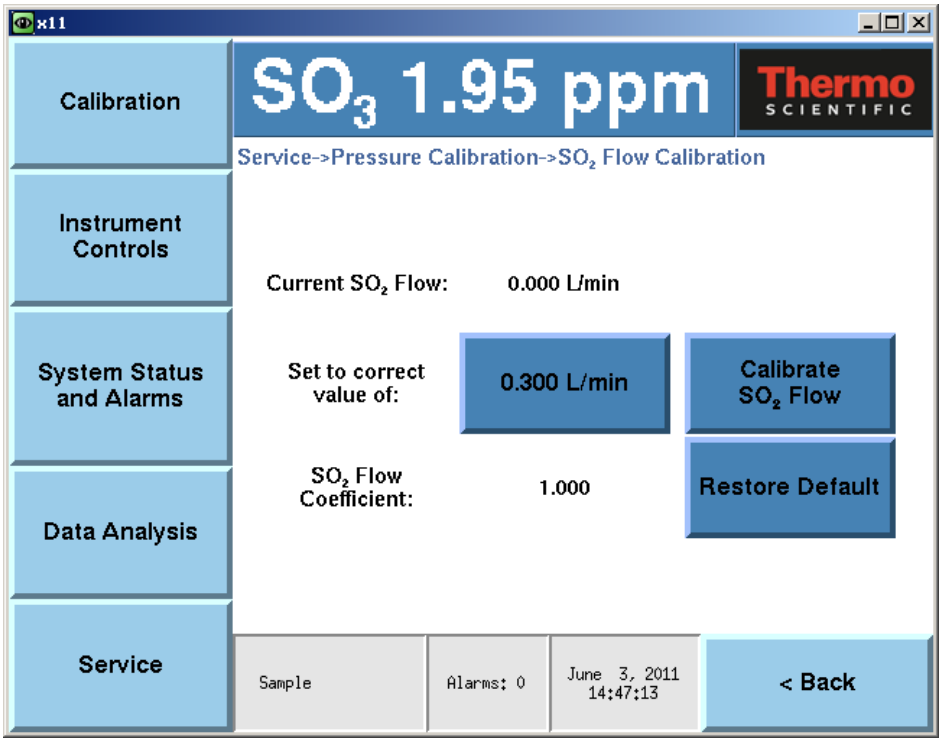


Figure 3–59. SO_2 Flow Calibration Screen

The SO_2 Flow Calibration screen contains the following information:

- *Current Flow*. Displays current SO_2 flow.
- *Set to correct value of*. Using a calibrated flow meter, the user measures the flow of SO_2. The user enters the correct flow using the keypad.
- *Calibrate SO_2 Flow*. Based on the current flow and correct value entered by the user, this button adjusts the SO_2 flow coefficient thus calibrating the current SO_2 flow reading.
- *SO_2 Flow Coefficient*. This flow coefficient value is the result of pressing the Calibrate Flow button. This coefficient will be applied to the raw flow value coming from the board.
- *Restore Defaults*. When pressed, the coefficient will be set to 1.000. The displayed flow will equal the raw flow coming from the board.

Laser Controls

The Laser Control screen (Figure 3–60) is used to adjust laser setting which affects the SO_3 spectrums and concentration.

The screen responds with "Are you Sure?" and requires a Yes or No action.

Equipment Damage Adjusting the laser control by a non-qualified individual can result in damages to the laser and laser housing. ▲

Note Each of these buttons function the same way. Each button will lead to a keypad where the user can enter new values. ▲

Note The laser power (controlled in the component power screen) cannot be turned on unless both the laser cooler temperature and the laser housing cooler temperature have reached within 1 °C of their setpoints. ▲

Note Once the laser is started and running, if the laser cooler temperature or the laser housing cooler temperature is turned off or creates an alarm then, the laser power is turned OFF. ▲

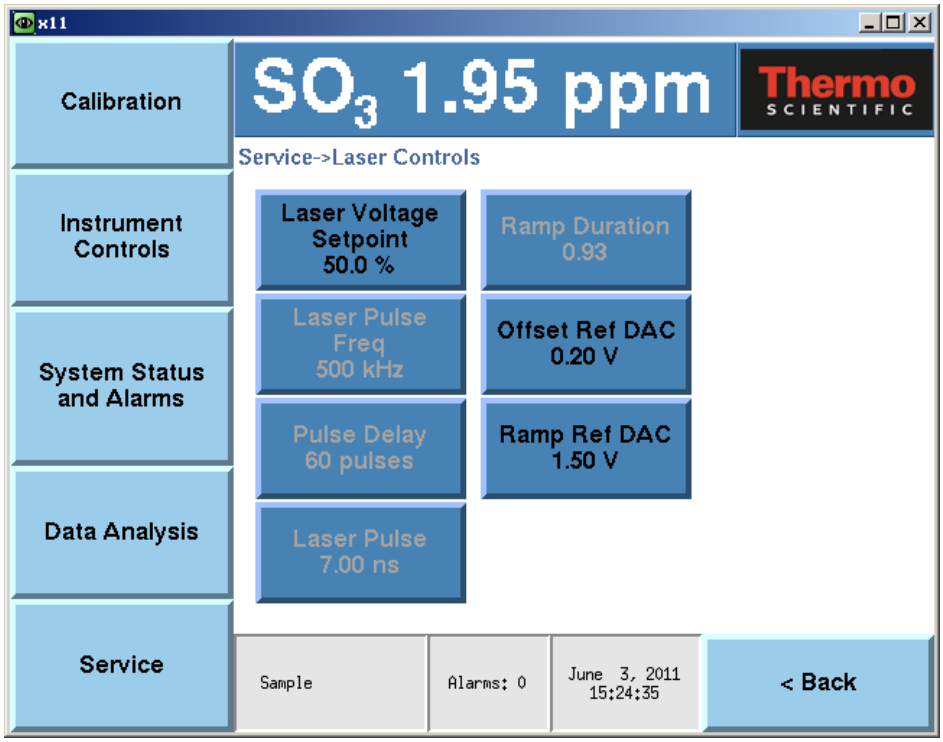


Figure 3–60. Laser Controls Screen

The Laser Controls screen allows the user to adjust the following laser parameters:

- *Laser Voltage Setpoint*. Laser pulse voltage.
- *Laser Pulse Freq*. Laser pulse repetition rate.
- *Pulse Delay*. Delay between series of pulses.
- *Laser Pulse*. Width of the laser pulse.
- *Ramp Duration*. Pulse duration used to calculate Ramp Ref DAC.
- *Offset Ref DAC*. This voltage is proportional to DC offset for the laser.
- *Ramp Ref DAC.* This voltage is proportional to ramp amplitude

See Table 3–5 for the default minimum, and maximum laser values.

Table 3–5. Laser Values (Default)

Laser Control	Default	Minimum	Maximum
Laser Voltage Setpoint	50	0%	100%
Laser Pulse Clock Frequency (kHz)	500	400	500
Delay (ns)	60	60	241
Laser Pulse (ns)	7	3.75	50
Laser Ramp (ramp duration) (us)	0.925	0	1.275
Offset Reference DAC (V)	0.2	0	2.5
Ramp Reference DAC (V)	1.5	0	2.5

Centering the SO_3 peak on channel 0. During a calibration, it is imperative that the SO_3 peak is between -10 to 10 as seen at the transmission spectrum screen. This is the calibration window. If during system span the SO_3 peak is outside this window, the laser setpoint temperature will need to be changed in order to center the SO_3 peak near channel 0. Laser temperature can be changed in the menu, System Status and Alarms. While in System Span mode, increasing laser temperature will move the SO_3 peak to the right as seen in the transmission spectrum screen. Decreasing the laser temperature will move the SO_3 peak to the left in the transmission spectrum screen. The goal is to center the SO_3 peak so that the peak channel number (located below the transmission spectrum) reads 0.

Note This procedure can be automatically done if the Peak Adjust button is enabled at the screen Calibration > Auto Calibration Schedule. ▲

Detector Controls

The Detector Control screen (Figure 3–61) is used to adjust the SO_3 detector. Changing these settings will affect the SO_3 spectrum and concentration.

The screen responds with "Are you Sure?" and requires a Yes or No action.

WARNING Adjusting the detector controls by a non-qualified individual can result in damages to the detector. ▲

Note Each of these buttons function the same way. Each button will lead to a keypad where the user can enter new values. ▲

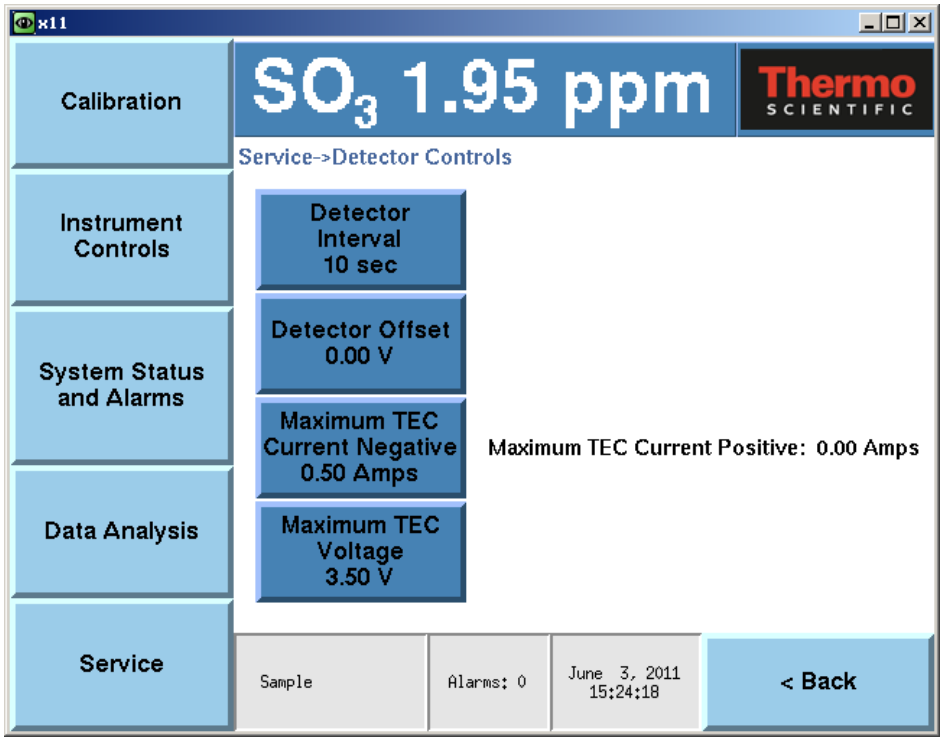


Figure 3–61. Detector Controls Screen

The Detector Controls screen allows the user to adjust the following detector parameters:

- *Detector Interval*. The amount of time that spectrum data is collected and averaged.
- *Detector Offset*. Detector voltage; baseline offset.
- *Maximum TEC Current Negative*. Default is 0.5 Amp.

- *Maximum TEC Voltage*. Default is 3.5 V.
- *Maximum TEC Current Positive*. = Maximum TEC current negative divided by 4 = 0.125 Amp.

See Table 3–6 for the default minimum, and maximum detector values.

Table 3–6. Detector Values (default)

Detection Control	Default	Minimum	Maximum
Detector Interval (second)	10	5	30
Detector Offset			
Maximum TEC Current Negative (amps)	0.5	0	1.25
Maximum TEC Voltages	3.5	0	10
Maximum TEC Current Positive (amps)	N/A	0	0.3125

Manual SO_2 Spike

The Manual SO_2 Spike screen (Figure 3–62) is used for diagnosing problems and locating the correct SO_3 peak area. The Manual SO_2 spike feature does not need to be routinely performed. When enabled, SO_2 gas will bypass the SO_3 generator and enter into the probe as SO_2 gas. This will be performed at the factory prior to shipment for two reasons:

1. ***Frequency Validation***. A large amount of SO_2 gas will be sent through the system bypassing the SO_3 generator creating large SO_2 peaks on the spectrum. We use these SO_2 peaks to locate the correct area of the spectrum to measure SO_3. We will then turn off the Manual SO_2 spike and use normal amounts of SO_3 to fine tune the frequency used for SO_3.

2. ***SO_3 Generator Efficiency***. During an SO_3 calibration, the SO_2 peak area can be monitored to ensure that the SO_3 generator is efficiently converting SO_2 to SO_3.

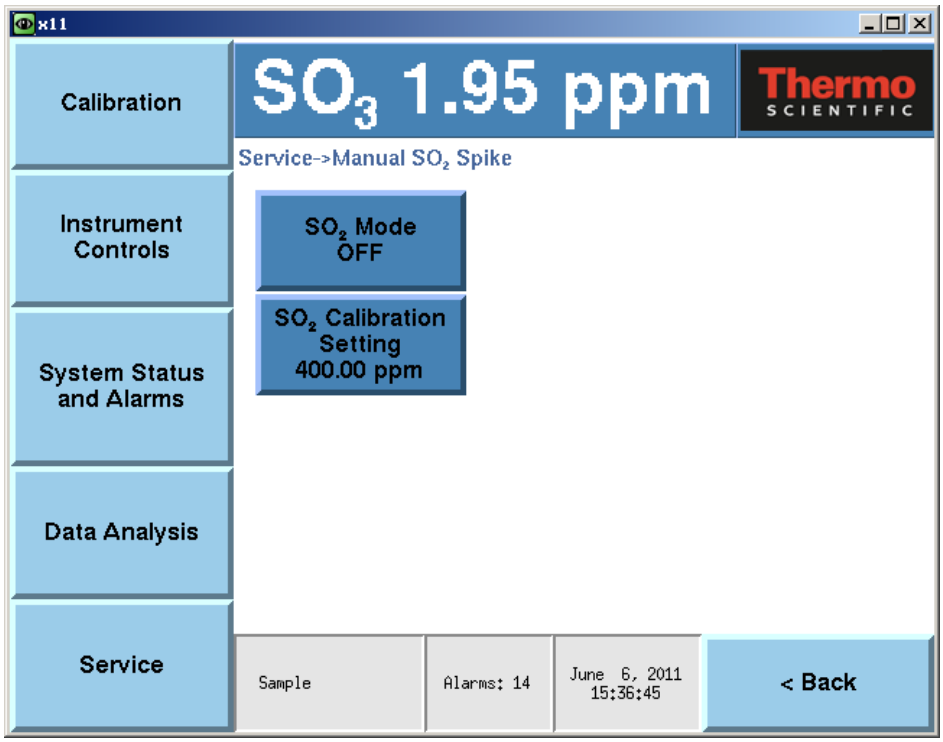


Figure 3–62. Manual SO_2 Spike Screen

The Manual SO_2 Spike screen contains the following information:

- *SO_2 Mode*. Toggles ON or OFF. When ON, this allows the SO_2 to bypass the SO_3 generator, sending SO_2 gas through the system to the bench.
- *SO_2 Calibration Setting*. Sets the SO_2 concentration during SO_2 mode.

Note Variables within the SO_2 Calibration Setting menu are separate from the Calibration Span Settings in the Calibration menu. ▲

Actions that take place when SO_2 mode is enabled:

- Gas mode goes to: SO_2 mode
- The top banner will say SO_2 instead of SO_3
- The top banner is in Green instead of Blue
- SO_2 spike valve turns on
- MFC's turn on
- System remains in SO_2 mode until disabled or until another gas mode is selected
- LaserVoltageSaved: When turned ON, the current SO_3 laser voltage is **saved** and **restored** once SO_2 mode is aborted

SO_2 Calibration Setting

The SO_2 Calibration Setting screen (Figure 3–63) is used to set the SO_2 span flow and calibration dilution air flow used during SO_2 mode.

Note Variables within this menu are separate from the Calibration Span Settings in the Calibration menu. When the Manual SO_2 Spike is disabled or another gas mode is selected, the flow setting will return to the settings in the menu Calibration > Calibration Setting. ▲

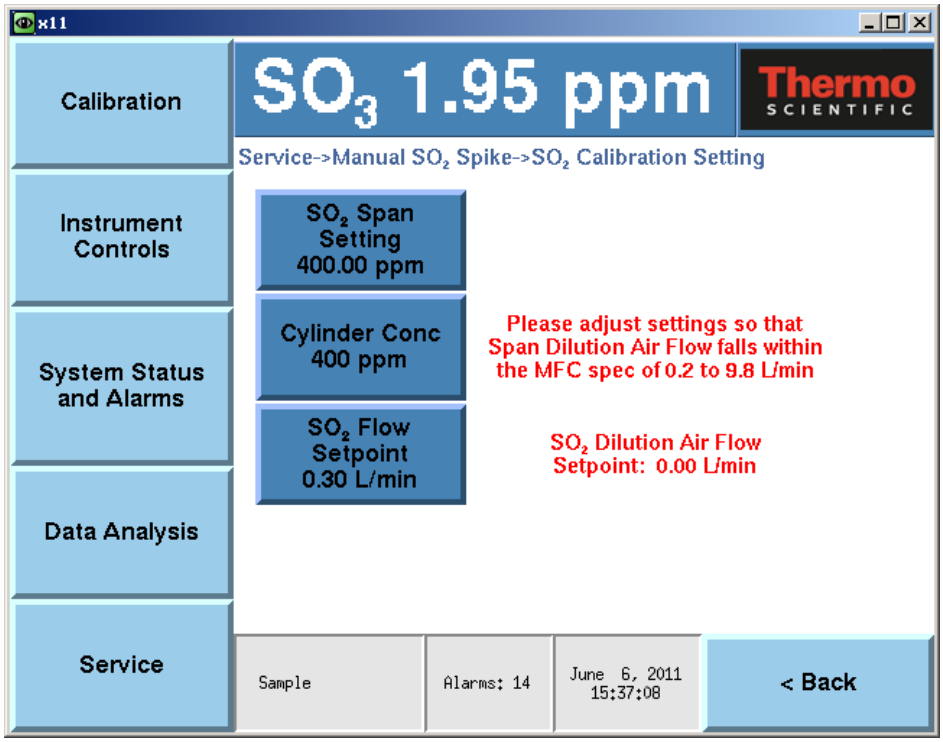


Figure 3–63. SO2 Calibration Setting Screen

The SO_2 Calibration Setting screen contains the following information:

- *SO_2 Span Setting*. Sets the span concentration for SO_2 mode.
- *Cylinder Concentration*. The cylinder concentration value should be set to the concentration of the SO_2 cylinder.
- *SO_2 Flow Setpoint*. The SO_2 Flow value sets the SO_2 MFC flow during a manual SO_2 spike. Allowable setpoints are from 0.020 to 0.480 L/min.
- *Calibration Dilution Air Flow*. The calibration dilution air flow is calculated from the three variables above. The calibration dilution air

flow MFC will be set to this value during a manual SO_2 spike. Allowable setpoints are from 0.20 to 9.80 L/min.

Note Setting the 3 variables will calculate the Cal Dilution Air Flow. If the variables entered make the Cal Dil Air Flow value out of range, the value will show in RED. ▲

Restore Factory Defaults

The Restore Factory Defaults screen (Figure 3–64) is used to restore system settings to original values set at the factory prior to shipment.

The screen responds with "Are you Sure?" and requires a Yes or No action.

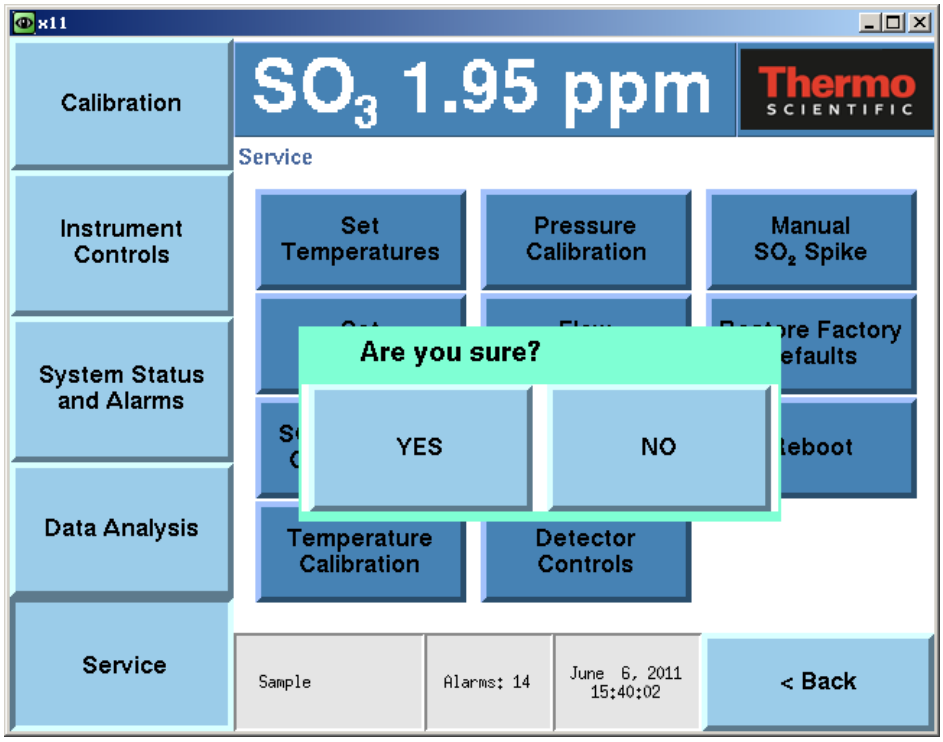


Figure 3–64. Restore Factory Defaults Screen

Reboot

The Reboot screen (Figure 3–65) is used to reboot or shutdown the system.

The screen responds with "Are you Sure?" and requires and Yes or No action.

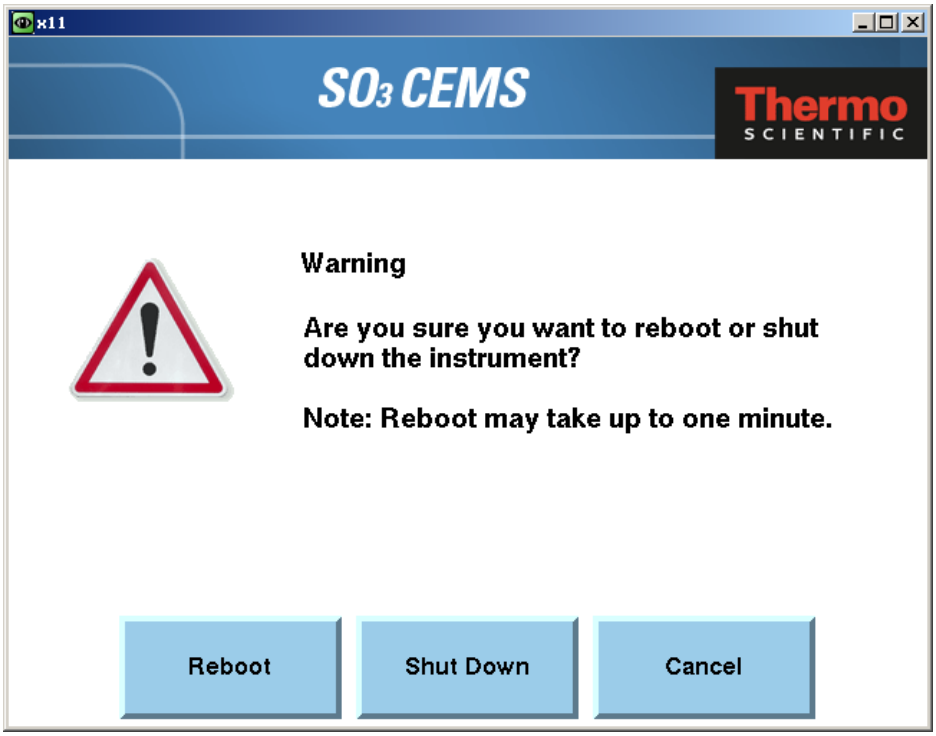


Figure 3–65. Reboot Screen

The Reboot screen contains the following information:

- *Reboot*. Reboots the system.
- *Shutdown*. Will shutdown the system requiring a physical startup.

Export to USB Flash Drive

Data logging data can be downloaded to a portable USB flash drive (Figure 3–66). Insert flash drive into the USB slot located on the instrument console. The user has the choice of downloading all records in the data logging table or downloading records since the last download. When finished, you can safely remove flash media from the instrument.

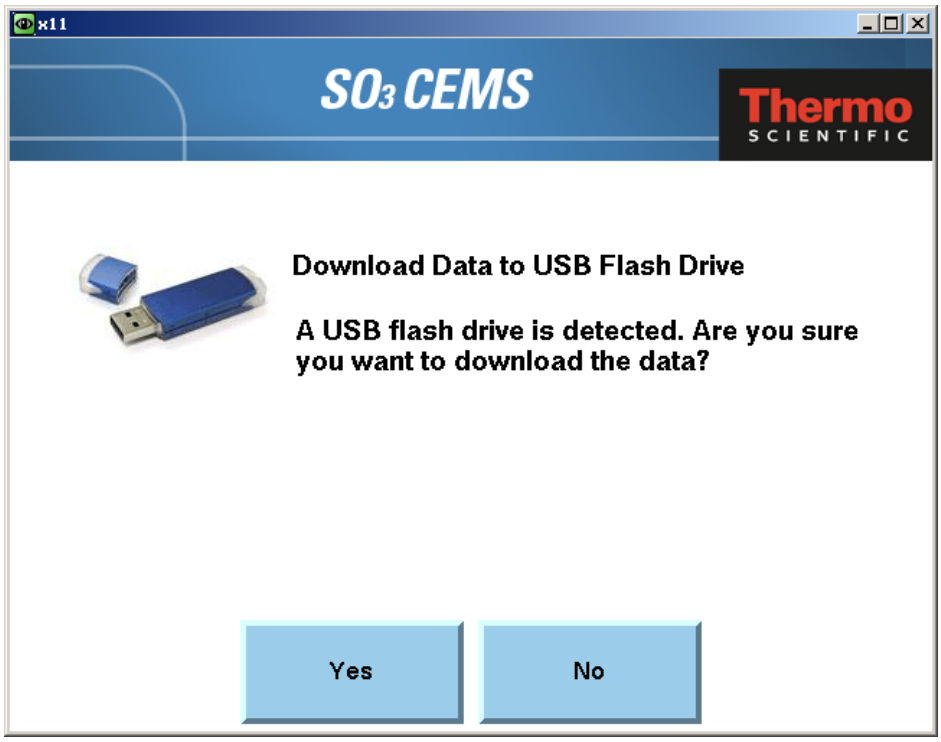


Figure 3–66. Export to USB Flash Drive Screen

For more information on "Downloading Data to a Flash Drive", see page B-15.

Chapter 4
Calibration

This chapter describes procedures for performing an SO_3 calibration of the Model 9800 SO_3 Instrument. The following sections discuss the required apparatus and procedures for calibrating the instrument.

- "Equipment Required" on page 4-1
- "Pre-Calibration" on page 4-1
- "Calibration" on page 4-2

Equipment Required

The following equipment is required to calibrate the instrument:

- 800 to 1200 ppm of SO_2 in Air cylinder

Pre-Calibration

This section describes how the user should set the SO_3 calibration span concentration.

Calibration Setting

The Calibration Settings screen located at Calibration > **Calibration Settings** should be configured to reflect the desired SO_3 calibration concentration. Proper cylinder concentrations and flow rates will also need to be set.

The following are the parameters that need to be set in the Calibration > Calibration Settings screen:

1. SO_3 Span Concentration – The SO_3 Span Concentration setpoint value is the span concentration setpoint used during System Span and Automatic System Span modes. The value chosen should be the highest concentration the user expects to measure during normal operation (Sample mode).

2. Cylinder Concentration – Enter the concentration of the SO_2 cylinder that you are using. Forethought should be used when determining what cylinder concentration to buy. Span concentration setpoint and calibration flow rates should be considered. It is suggested that a 1000 ppm SO_2 in Air cylinder be used.

3. SO_2 Flow Setpoint – This button sets the SO_2 gas flow rate to flow through the SO_3 Generator assembly. An SO_2 flow of 0.2 to 0.4 L/min is suggested. However, the operating range of this Mass Flow Controller is 0.02 to 0.48 L/min.

4. Span Dilution Air Flow Setpoint – When the three variables above are set, the instrument will automatically set the Span Dilution Air Flow Setpoint. The value is located to the right of the SO_2 Flow Setpoint button and must be within the operating range of the Span Dilution Air Flow Mass Flow Controller, which is 0.2 to 9.8 L/min. If the calculated value falls out of this range, an error message will appear and the user will need to adjust one or more of the three variables. Calibrations will not take place if this screen has an error message.

Note The combined flow rates should be at least 3 L/min. ▲

Note At the moment of span calibration, the span value will be used to calibrate the system. This value is found at System Status and Alarms > Instrument – Span Reading. This value is the real-time span reading based on the SO_2 MFC and Span Dilution Air MFC. ▲

Calibration

This section describes how to setup and run an automatic calibration.

Automatic Calibration Schedule

Perform the following pre-calibration procedure before calibrating the instrument. For detailed information about the menu parameters and the icons used in these procedures, see Chapter 3, "User Interface".

Note The calibration and calibration check duration times should be long enough to account for the transition (purge) process when switching from sample to zero and from zero to span. ▲

Note Depending on the umbilical length and sample location, data from the first several minutes of a zero calibration or check should be disregarded because of residual sample air. Also, data from the first several minutes of a span calibration or check should be disregarded because the span is mixing with the residual zero air. ▲

1. If recently powered on, allow the instrument to warm up and stabilize overnight.

2. Check to see that there are no alarms.

3. Go to the screen: Calibration > **Auto Calibration Schedule**

   a. Ensure that the "Enabled/Disabled" button says Enabled.

   b. If the "Next Time" is not set for the next desired Calibration time, click on the button and set the date-time you wish for the next calibration. Based on the "Period", this date-time will automatically update after the calibration starts.

   c. The "Period" is the amount of time in between scheduled calibrations. Set this to 24 hours if you wish to do a daily calibration at the same time each day.

   d. The "Duration" values determine the amount of time the system will be in Auto System Zero mode and Auto System Span mode. The user will want to set the duration times to a high enough value so that residual air is purged out of the system at the point of calibration. A duration of 60 minutes for zero air and 60 minutes for span is suggested.

   e. The user has the option of setting the Auto Calibration averaging time to a different value than the averaging time used during normal operation. Some users set the Auto Calibration SO_3 Averaging Time to a greater value than the Sample SO_3 Averaging Time (found in the menu Instrument Controls > Averaging Time). It is recommended that during calibration, a higher averaging time should be used for best results. For instance, if the Auto Calibration "SO_3 Averaging Time for Auto Cal" is set to 180 seconds, then the last 180 seconds worth of concentration data during the zero duration will be used to set the Zero background and the last 180 seconds of concentration data during the span duration will be used to set the span coefficient.

   f. The Current Cal date reflects the date and time of the last completed Auto Calibration Schedule.

   g. The Peak Adjust button, when enabled, centers the SO_3 peak over channel 0. To view the SO_3 peak, go to the screen Data Analysis > Real Time Spectrum > Transmission Spectrum during System Span mode or Auto System Span mode. During the span duration, the laser temperature will be automatically adjusted in order to center the SO_3 peak within the measurement window of channels -10 to 10. If the SO_3 peak is located to the right of channel 0 (peak channel number greater than 0), the laser cooler setpoint temperature will be automatically decreased. If the SO_3 peak is located to the left of channel 0 (peak channel number less than 0), the laser cooler temperature will be automatically increased.

When the instrument time matches the "Next Time" date-time in the Automatic Calibration Schedule screen, the automatic calibration will begin. The following events will occur during an Automatic Calibration Schedule:

Table 4–7. Automatic Calibration Schedule of Events

	Mode	Duration	Purpose
1	Auto Filter Blowback	10 seconds	Cleans probe of stack debris
2	Auto Stinger Blowback	10 seconds	Cleans stinger of stack debris
3	Auto System Zero	Zero Duration	Floods the probe with zero air. At the end of this mode, the Zero background will be set.
4	Auto System Span	Span Duration	Floods the probe with span gas. At the end of this mode, the Span coefficient will be set and the Zero background will be adjusted accordingly. If Peak Adjust is enabled, the SO_3 peak will be centered towards 0 at the end of the span duration.

At the end of the Automatic Calibration Schedule, the system will go to Sample mode.

Automatic Calibration Check and Automatic Calibration Schedule

The Automatic Calibration Check Schedule has the same operating parameters as the Auto Calibration Schedule. However, there are some differences in function. The Check Schedule does not set a new Zero background or Span coefficient and does not offer automatic Peak Adjust. The function of this schedule is not to calibrate the instrument. Rather it will go through all the gas mode events of a calibration without actually changing the Zero background and Span coefficient.

Manual Calibration

The Manual Calibration, located at the screen Calibration > Manual Calibration, allows the user to calibrate the system without using the Automatic Calibration Schedule. The following are steps that can be taken to calibrate the system using the Manual Calibration feature:

1. Go to the screen, Instrument Controls > **Averaging Time**. Record what the averaging time is set to. Change the averaging time to a value greater than or equal to 180 seconds.

2. Set the instrument Gas mode to Filter blowback for approximately 10 seconds.

3. Set the instrument Gas mode to Stinger blowback for approximately 10 seconds.

4. Set the instrument Gas mode to Zero mode.

5. After approximately 40–60 minutes of Zero Air, at the screen Calibration > Manual Calibration press the “Set Bkg” button. This will set the new Zero background based on the displayed SO_3 concentration reading.

6. Set the instrument Gas mode to Span mode.

7. After approximately 40–60 minutes of Span gas, at the screen Calibration > Manual Calibration, press the “Set Span” button. This will set the new Span coefficient based on the displayed SO_3 concentration and the SO_3 Span reading (as calculated from the MFC slows located at the screen, System Status and Alarms > Instrument).

8. Go to the screen, Instrument Controls > **Averaging Time**. Set the Averaging time to the original setting.

9. Put the System in Sample mode.

Chapter 5
Preventive Maintenance and Servicing

This chapter includes the following maintenance information and replacement procedures that should be performed on the 9800 SO3 Analyzer and PRO9805 Probe to ensure proper operation (or is an "expendable" item not covered under warranty). Expendable items are indicated by an asterisk (*) in the table. All plumbing type replacements should be followed-up with a leak test. For details, see the following:

- "Safety Precautions" on page 5-2
- "9800 SO3 Analyzer Replacement Parts List" on page 5-3
- "Factory Plumbing" on page 5-4
- "9800 SO3 Analyzer Replacement Tubing List" on page 5-4
- "Shutdown Instructions" on page 5-5
- "AC Mains Assembly Replacement" on page 5-6
- "Pneumatic Assembly Replacement" on page 5-7
- "Optical System Assembly" on page 5-9
- "System Electronics Assembly" on page 5-11
- "User Interface Assembly" on page 5-12
- "Air Conditioner Replacement" on page 5-14
- "PRO9805 Probe Replacement Parts List" on page 5-15
- "Factory Plumbing" on page 5-16
- "Replacement Tubing List" on page 5-16
- "Factory Wiring" on page 5-19
- "Dilution Eductor Replacement" on page 5-22
- "Inertial Filter Replacement" on page 5-23
- "Dilution Assembly Critical Orifice Replacement" on page 5-24
- "15 Micron Filter Replacement" on page 5-25

- "Valve Cover Gasket Replacement" on page 5-25
- "Valve Assembly Replacement" on page 5-27
- "Venturi Pressure Differential Transducer Assembly Replacement" on page 5-28
- "Stinger Heater Replacement" on page 5-28
- "Stinger Clamp Replacement" on page 5-29
- "Eductor Replacement" on page 5-29
- "Venturi Tube Replacement" on page 5-29
- "SO3 Generator Replacement" on page 5-29
- "Service Locations" on page 5-30

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.

WARNING The service procedures in this manual are restricted to qualified service technicians. ▲

WARNING If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

9800 SO_3 Analyzer Replacement Parts List

Table 5–1 lists the replacement parts for the 9800 SO_3 Analyzer.

Note The recommended replacement interval is site specific; therefore, these are only guidelines. ▲

Table 5–1. 9800 SO_3 Analyzer Replacement Parts

Part Number	Description	Replacement Interval
111188-00	Power Supply, ATX	As needed
111110-00	Hard drive, 80gb	As needed
1111542-00	Touch screen assembly	As needed
109660-00	Com express board	As needed
109918-00	Temperature control board	As needed
109512-00	Photo detector board	As needed
109930-00	MIB	As needed
109496-00	Power distribution board	As needed
110656-00	Pneumatic assembly	As needed
102631-00	Mass flow controller, 10LPM	As needed
110803-00	Mass flow controller, 500 sccm	As needed
110976-00	Pressure transducer assembly	As needed
2136.336	Solenoid valve	As needed
103211-00	Pressure transducer (2-60 psig)	As needed
110657-00	AC Mains assembly	As needed
111127-00	Fuse, cartridge, 30 Amp	As needed
110137-00	Optical bench assembly	As needed
109755-00	Optical system assembly	As needed
110646-00	Detector housing assembly	As needed
109757-00	Laser assembly	As needed
111048-00	AC Unit, 3000 BTU/HR	As needed

Factory Plumbing

Table 5–4 lists the replacement tubing parts for the 9800 SO_3 Analyzer. Refer to Figure 5–1 to identify the component location. This figure illustration and table allow for easy tube reattachment or replacement.

9800 SO_3 Analyzer Replacement Tubing List

Table 5–4 lists the replacement tubing parts for the 9800 SO_3 Analyzer. Refer to Figure 5–1 to identify the component location.

Depending on the conditions of the stack or duct, annual replacement of factory tubing should be performed. An ideal time would be shut-down.

Table 5–2. 9800 SO_3 Analyzer Replacement Tubing

Number	Description	Tubing Length	Nut and Ferrule set
1	Eductor in to 'A'-3/8 PTFE	18"	(2) 3/8″ S.S.
2	Blow back to 'B'-3/8 PTFE	36"	(2) 3/8″ S.S.
3	Dilution air to 'C'-1/4 PTFE	16"	(2) 1/4″ S.S.
4	Cal dilution to 'D'-1/4 PTFE	18"	(2) 1/4″ S.S.
5	Pump to optical bench-1/4 PTFE	18"	(2) 1/4″ S.S.
6	CDA in to 'E'-3/8 PTFE	36"	(2) 1/4″ S.S.
7	SO2 To Probe to 'F'- 1/4 PTFE	18"	(2) 1/4″ S.S.
8	Zero air to 'G'- 1/4 PTFE	36"	(2) 1/4″ S.S.
9	SO2 in to 'H'- 1/4 PTFE	36"	(2) 1/4″ S.S.
10	'K' to 'J'-1/4 PTFE	6"	(2) 1/4″ S.S.

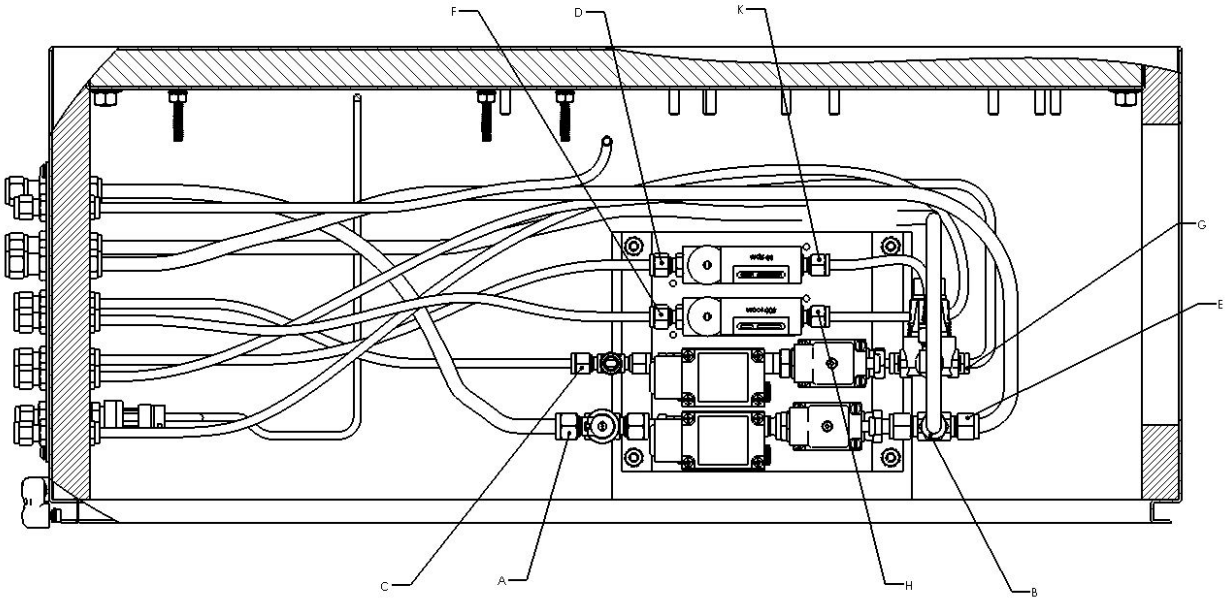


Figure 5–1. Pneumatic Tubing Detail

Shutdown Instructions

Refer to the following steps when a procedure requires shut down of the instrument.

1. At the User Interface screen, choose Service > **Shutdown** to shut down the system.

2. Locate the power switch on the right side of the instrument chassis. Turn switch to the OFF position.

3. Unplug 220V power cord from power source.

4. Unplug the pump cable from power source.

AC Mains Assembly Replacement

The AC Mains Assembly is attached to the back of the Instrument Chassis below the User Interface Assembly. Use the following procedure to replace the AC Mains Assembly (Figure 5–2).

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Perform shut down of the system. Refer to "Shutdown Instructions" in this chapter.

2. Locate the AC Mains Assembly (Figure 5–2). There are two (2) wires that lead from the black, fused terminal blocks to the AC Mains power switch. Disconnect these wires from the terminal blocks.

3. There are three (3) green/yellow ground wires that need to be disconnected from the instrument chassis. One is connected from the line filter to the chassis. Remove the nut that attaches the ground wire to the instrument chassis. The other two are connected from the green/yellow terminal blocks to the chassis. Remove the nuts that attach these two ground wires to the chassis.

4. There are three (3) AC breakers with two (2) wires connected to each. The left AC breaker powers the heaters connected to the Power Distribution board. The middle AC breaker connects to the Power Supply. The right AC breaker connects to the AC unit. Remove all six (6) wires from the bottom of the three breakers. Label each wire when disconnecting to ensure proper reinstallation.

5. Remove the four (4) nuts that secure the AC Mains bracket to the chassis.

6. Remove AC Mains Assembly.

7. To reinstall, follow the above instructions in reverse.

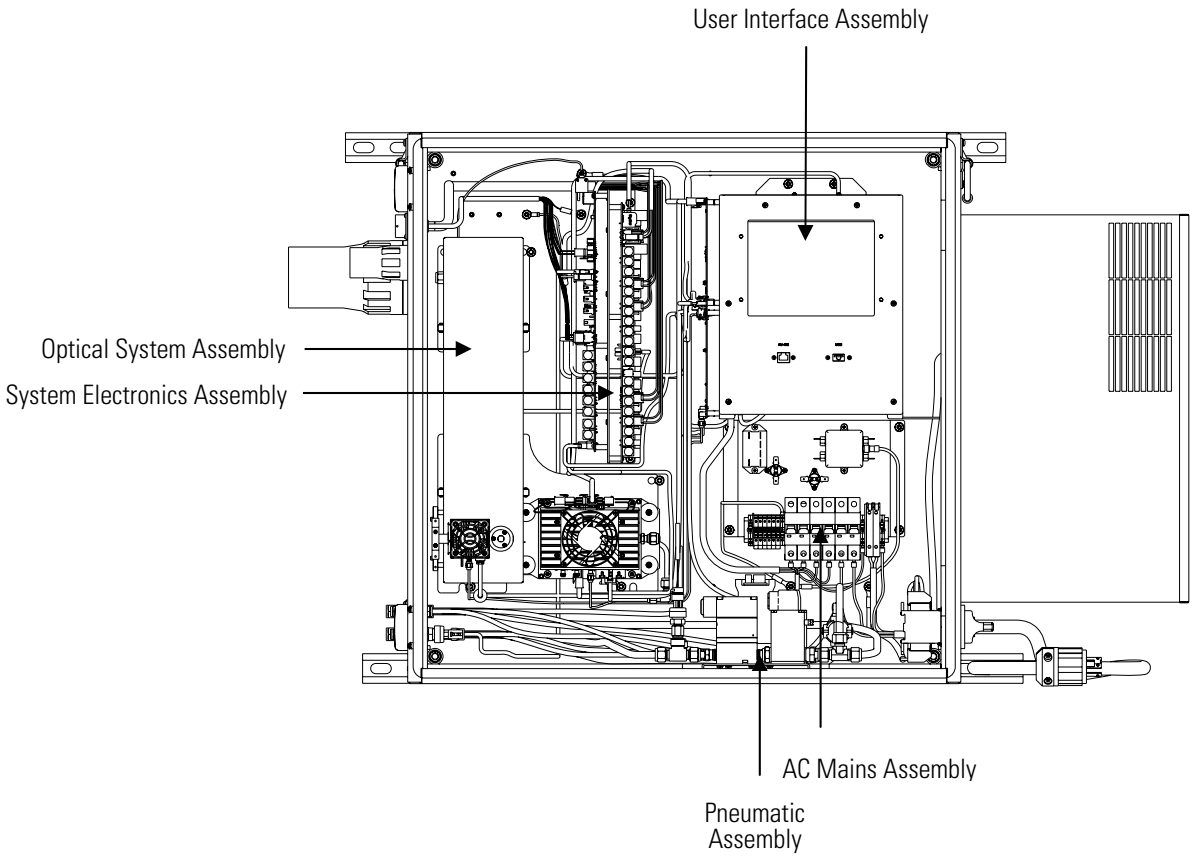


Figure 5–2. Component Location

Pneumatic Assembly Replacement

The Pneumatic Assembly is attached to the bottom of the instrument chassis below the User Interface Assembly. When removing, it is suggested that the cables should be labeled in order to ensure proper reinstall. Use the following procedure to replace the Pneumatic Assembly (Figure 5–3).

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Perform shut down of the system. Refer to "Shutdown Instructions" in this chapter.

2. Turn off air supply to the instrument.

3. On the System Control board, located closest to the Optical Bench Assembly, disconnect the (two) 2 transducer cables from connectors J23 (Eductor) and J7 (Dilution).

4. On the System Control Board, disconnect the two (2) regulator valve cables from connectors J39 (Eductor) and J31 (Dilution).

5. On the System Control board, disconnect the two (2) mass flow control cables from connectors J33 (Air) and J32 (SO2).

6. Locate the Pneumatic Assembly. It is bolted to the bottom of the instrument chassis directly to the left of the main power switch. The Pneumatic Assembly consists of 2 transducers, 2 valves and 2 mass flow controllers, and a fixed pressure regulator.

7. The cables are attached to the chassis with tie straps. Cut the tie straps in order to free the 6 cables. Free cables from chassis and any entanglements.

8. Disconnect the two (2) tees connected to the transducers, the two (2) tees connected to the valves, and the four (4) tubes connected to the mass flow controllers. Label each disconnected part to ensure proper reinstallation.

9. Remove the four (4) nuts that secure the Pneumatic Assembly to the chassis.

10. Remove the Pneumatic Assembly.

11. To reinstall, follow the above instructions in reverse.

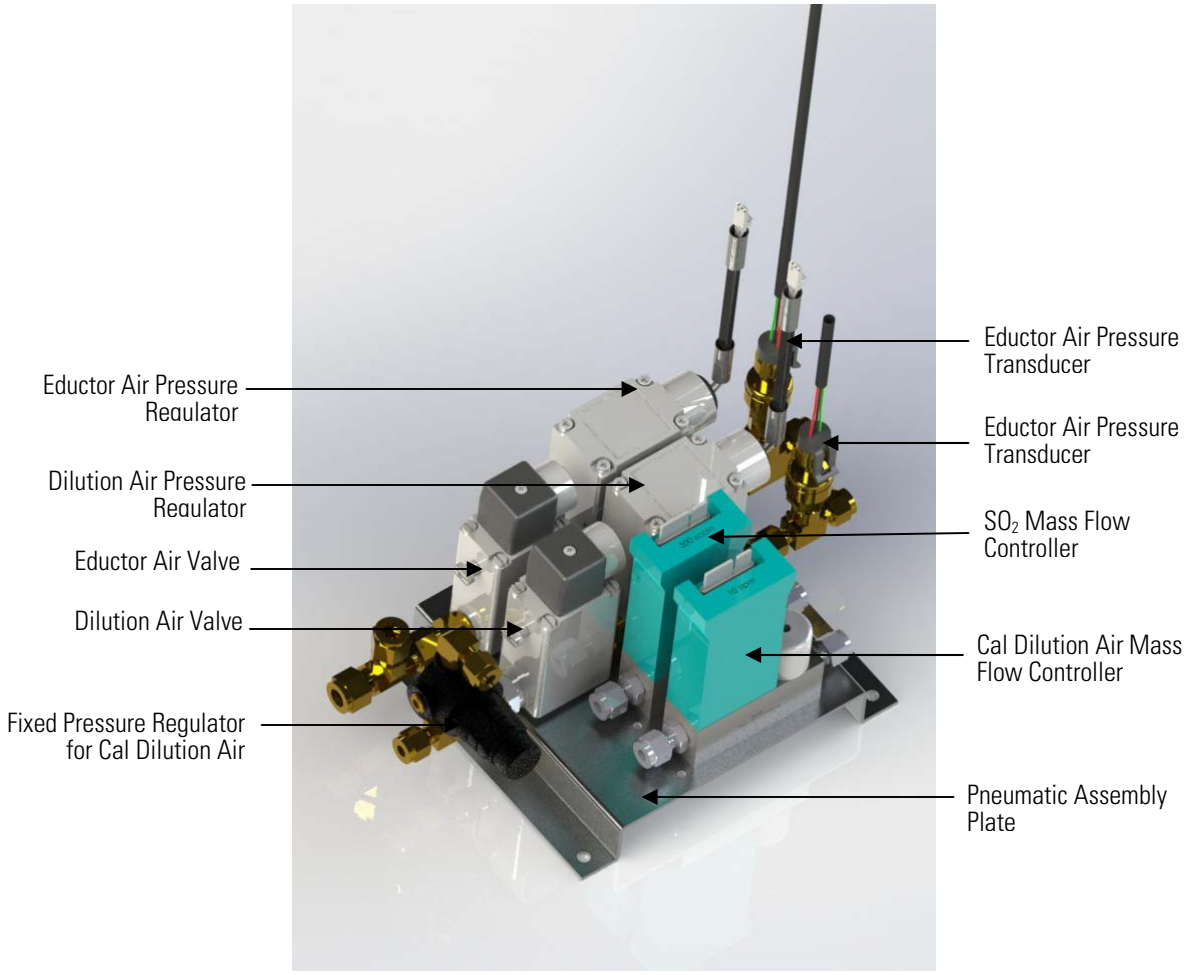

Eductor Air Pressure Regulator
Dilution Air Pressure Regulator
Eductor Air Valve
Dilution Air Valve
Fixed Pressure Regulator for Cal Dilution Air
Eductor Air Pressure Transducer
Eductor Air Pressure Transducer
SO_2 Mass Flow Controller
Cal Dilution Air Mass Flow Controller
Pneumatic Assembly Plate

Figure 5–3. Pneumatic Assembly

Optical System Assembly

The Optical System Assembly consists of the Bench Assembly, Laser Assembly, Detector Assembly and Mounting Bracket. The Mounting Bracket will be removed from the Instrument Chassis and the Bench, Laser and Detector will remain attached to the mounting bracket. Use the following procedure to replace the Optical System Assembly (Figure 5–4).

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. At the User Interface screen choose Instrument Controls > Component Power > **Instrument**. Turn off the Laser & Detector Power, Laser Cooler, Laser Housing Cooler, and Detector Cooler.

2. Turn off the Sample Pump. Then wait 2 minutes for the bench pressure to reach atmospheric pressure.

3. At the top of the bench, disconnect the umbilical line.

4. At the bottom of the bench, locate the 1/4-inch stainless steel bench exhaust tubing that runs behind the laser assembly. To the right of the laser assembly is an elbow; disconnect the PFA tubing from the elbow.

5. Disconnect the bench thermocouple from the System Control board. Follow the bench thermocouple wire to the System Control board. It is the 9th one from the front. Untangle the wire so that it is free from other wires.

6. Disconnect the Bench heater wires from the Power Distribution board. It is located at position J6. Untangle the wire so that it is free from other wires.

7. At the Detector Assembly, remove the communication cable and the coax cable.

8. At the Detector Assembly locate the fan and follow the fan cord. Unplug the fan. Next, remove the fan from the detector assembly and place inside the chassis so that it is out of the way of the Optical System.

9. At the Laser Assembly, locate the fan on top of the heat sink, follow the wires to the laser board and disconnect the connector from the Laser board. Remove and place the fan inside the chassis so that it is out of the way of the Optical System.

10. At the Laser Assembly, disconnect the power cable, RS-485 cable, clock coax cable, and TEC cable. Before removing cables, make sure that they are labeled in order for proper re-install.

11. Remove the five (5) nuts that hold the Optical Assembly to the chassis.

12. Remove Optical Assembly from the chassis.

13. To reinstall, follow the above instructions in reverse.

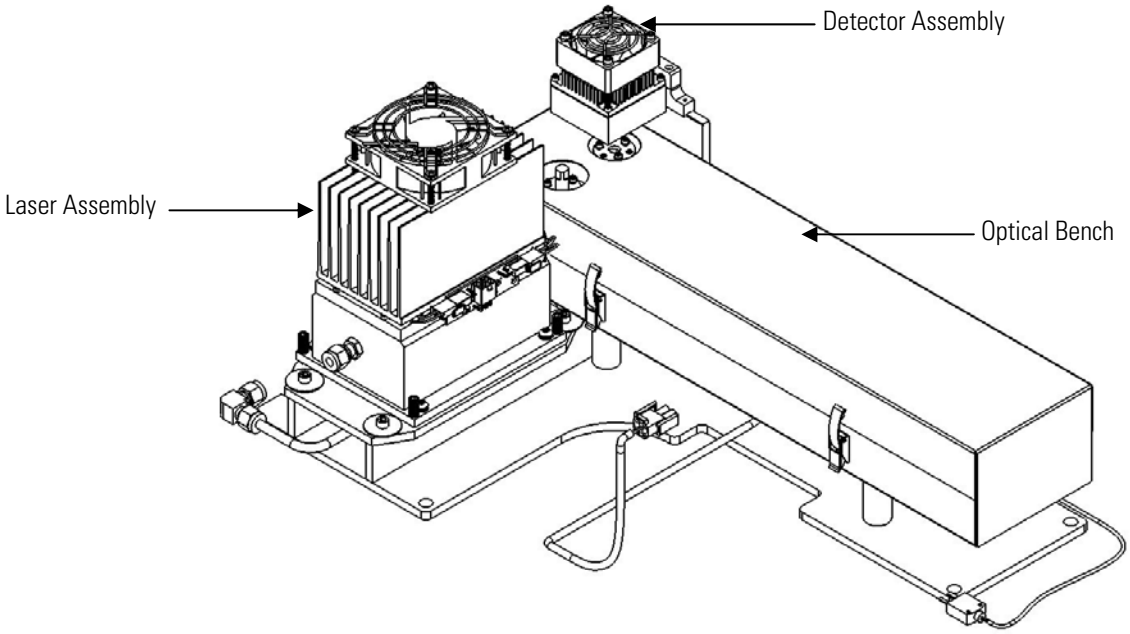


Figure 5–4. Optical Assembly Replacement

System Electronics Assembly

The System Electronics Assembly consists of two printed circuit boards and the System Electronics Bracket. When facing the instrument chassis, the board on the left is called the System Control board and the board on the right is the Power Distribution board. When disconnecting cables from either board, it is suggested that the cables are labeled in order to ensure proper reinstall. Use the following procedure to replace the System Electronics Assembly (Figure 5–5).

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Perform shut down of the system. Refer to "Shutdown Instructions" in this chapter.

2. Unplug all connectors from the System Control board and Power Distribution board.

   a. Make sure all cables are labeled to ensure proper reinstall.

   b. The colorful ribbon cables are connected to both boards. Do not forget to re-connect these when reinstalling.

3. When the two boards are free from all cables, remove the three (3) nuts holding it to the chassis.

4. To reinstall, follow the above instructions in reverse.

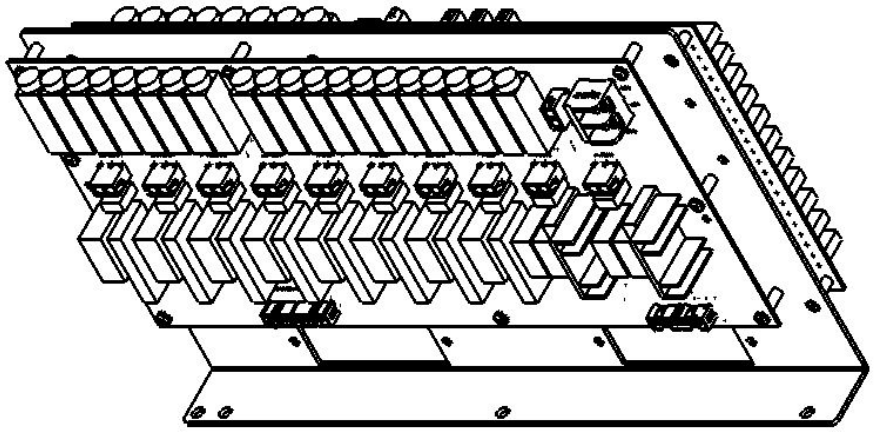


Figure 5–5. System Electronics Assembly Replacement

User Interface Assembly

The User Interface Assembly is located at the top right of the instrument Chassis. On the outside of the frame there are three (3) boards, which include the Laser board, Laser Housing board, and Detector board. Also on the outside of the frame is a touch screen, USB and Ethernet ports. Inside the box, you will find the Motherboard, hard drive, and touch screen electronics. When disconnecting cables from the boards, it is suggested that the **cables should be labeled** in order to ensure proper reinstall. Use the following procedure to replace the User Interface Assembly (Figure 5–6).

Note The Power Supply is connected to the Chassis, not the User Interface Assembly. ▲

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Perform shut down of the system. Refer to "Shutdown Instructions" in this chapter.

2. If there is a USB cable or Ethernet cable connected to the front of the User Interface, disconnect them.

3. Disconnect the Laser TEC connector from the Laser board. Disconnect the power cable (labeled PWR on board). Also, disconnect the RS-485 cable (position J6) that leads to the System Control board.

4. Disconnect the Laser Housing fan connector from the Laser board and TEC connector from the Laser Housing board.

5. Disconnect the Detector fan connector from the Laser board and the Detector TEC connector from the Detector board. Disconnect the power cable (labeled PWR on board).

6. At the Detector Board, unplug the detector communication cable that leads to the detector. Disconnect the coaxial cables, J7 and J3. Be sure to label cables. Disconnect the power cable (labeled PWR on board). Also, disconnect the RS-485 cable (position J6) that leads to the System Control board.

7. At the System Control board, disconnect the power cable which is daisy chained to the Power Supply on the Detector board. Make sure cable is free and untangled.

8. At the top of the User Interface box, there is an opening. The cable coming out of this square opening is the power supply cable. This cable is “daisy chained” in series and supplies power to all the boards and instrument components. This cable needs to be unplugged at all the connections. When fully disconnected, untangle cable from other cables so that it is free.

9. Remove the four (4) nuts holding the User Interface Assembly to the chassis.

10. Two people may be needed for the next step. When removing the User Interface Assembly from the chassis, the power supply cable will need to be snaked through the square hole at the top of the User Interface. The cable cannot be disconnected at the power supply.

11. Carefully pull the User Interface Assembly from the chassis while pushing the power supply cable through the square hole.

12. To reinstall, follow the above instructions in reverse.

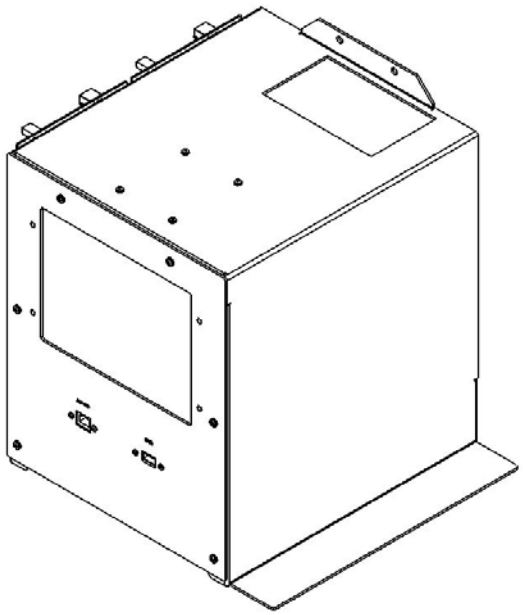


Figure 5–6. User Interface Assembly Replacement

Air Conditioner Replacement

Use the following procedure to replace the air conditioner.

1. Perform shut down of the system. Refer to "Shutdown Instructions" in this chapter.

2. Remove 3 wires from the **bottom** of the right-most breaker located at the AC Mains Assembly. Write down which color wire goes to each terminal.

3. Loosen 3 nuts located at the bottom of the air conditioner.

4. Lift Air Conditioner up and away from the Instrument Chassis mounting bar. The AC unit hangs from a mounting bar that is bolted to the Instrument Chassis.

5. To reinstall, follow the above instructions in reverse.

PRO9805 Probe Replacement Parts List

Table 5–3 lists the replacement parts for the 9805 Dilution Extractive Probe.

Note The recommended replacement interval is site specific; therefore, these are only guidelines. ▲

Table 5–3. PRO9805 Probe Replacement Parts

Part Number	Description	Replacement Interval
102624-00	Dilution Eductor	As needed
101074-00	Filter, 15 Micron	Annual
110214-00	Filter, Inertial (coated)	As needed or cleaned
103571-00	Fitting Adapter Assembly	As needed
111368-00	Orifice, Critical, .011 ID	As needed
110172-00	Ash Deflector	As needed or cleaned
105479-00	Strain Relief Assembly	As needed
102623-00	Sulfinert Cross	As needed
110833-00	Valve Assembly (no offset)	As needed
110833-01	Valve Assembly (45° offset)	As needed
110833-02	Valve Assembly (90° offset)	As needed
103434-00	Venturi Differential Pressure Transducer Assembly	As needed or cleaned
103570-00	Venturi Tube Assembly	As needed
100634-00	Graphite Ferrule, 1/2-inch*	When replacing stinger tube or as needed
100635-00	Graphite Ferrule, 3/4-inch*	When replacing return tube or as needed
103709-00	Stinger Clamp Assembly	As needed
103657-00	Stinger Heater, up to 3 feet	As needed
103658-XX	Stinger Heater, 3–6-feet	As needed
110093-00	Heater, Cartridge, Fast Loop BLock	As needed
102989-00	Critical Orifice Stainless, Coated	As needed
110229-00	Gasket, Cover	As needed
110230-00	Gasket, Face Plate	As needed

*Expendable item not covered by warranty.

Factory Plumbing

Table 5–4 lists the replacement tubing parts for the 9805 Dilution Extractive Probe. Refer to Figure 5–7 through Figure 5–11 to identify the component location. These figure illustrations and table allow for easy tube reattachment or replacement.

Replacement Tubing List

Table 5–4 lists the replacement tubing parts for the 9805 Dilution Extractive Probe. Refer to Figure 5–7 through Figure 5–11 to identify the component location.

Depending on the conditions of the stack or duct annual or more/less frequent, replacement of factory tubing should be performed. An ideal time would be shut-down.

Table 5–4. 9805 Dilution Extractive Probe Replacement Tubing

Number	Description	Tubing Length	Nut and Ferrule set
1	Stinger BB Valve in to Acc Tank Bottom Tee	9-1/2″	(2) 1/4″ S.S.
2	Filter BB Valve in to Acc Tank Bottom Tee	12″	(2) 1/4″ S.S.
3	BB in port to Acc Tank	18″	(2) 1/4″ S.S.
4	Stinger BB Valve out to BB Fitting	39″	(2) 1/4″ S.S.
5	Filter BB Valve out to Filter Fitting	43″	(2) 1/4″ S.S.
6	SO_2 Valve out to SO2 top generator	46″	(2) 1/4″ S.S.
7	SO_3 Valve out to bottom fitting on generator	43″	(2) 1/4″ S.S.
8	Diff Press Hi Side to tube “Hi” Fitting	13″	(2) 1/4″ S.S.
9	Diff Press Lo Side to tube “Lo” Fitting	12″	(2) 1/4″ S.S.
10	Cal Gas Dil port to Cal Fitting (Pre heat)	29″	(2) 1/4″ S.S.
11	Vacuum Port to Vacuum	34″	(2) 1/4″ S.S.
12	Eductor Port to Eductor	50″	(2) 1/4″ S.S.
13	Dilution Port to Dilution In	56″	(2) 1/4″ S.S.
14	Cal Gas Dil (Post heat) to generator	7″ PTFE 8″ Insulation	(2) 1/4″ S.S.

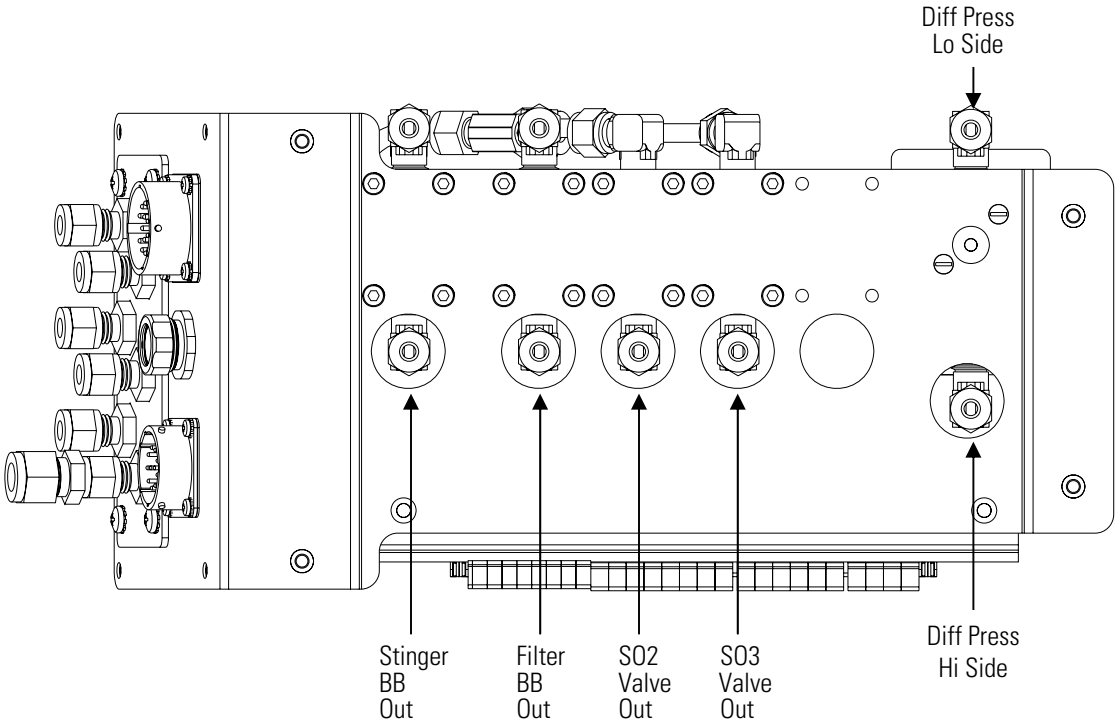


Figure 5–7. Fitting Locations – Undersides of Valves

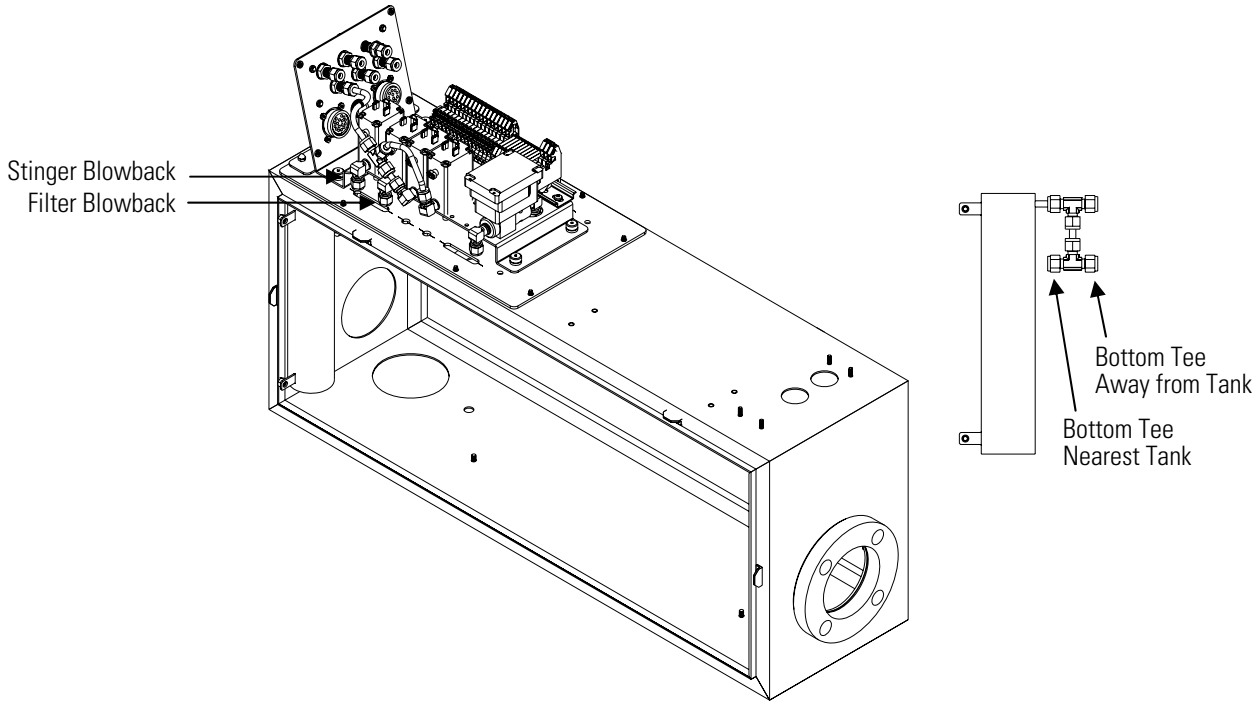


Figure 5–8. Fitting Locations – Blow Back Valves and Accumulator Tank

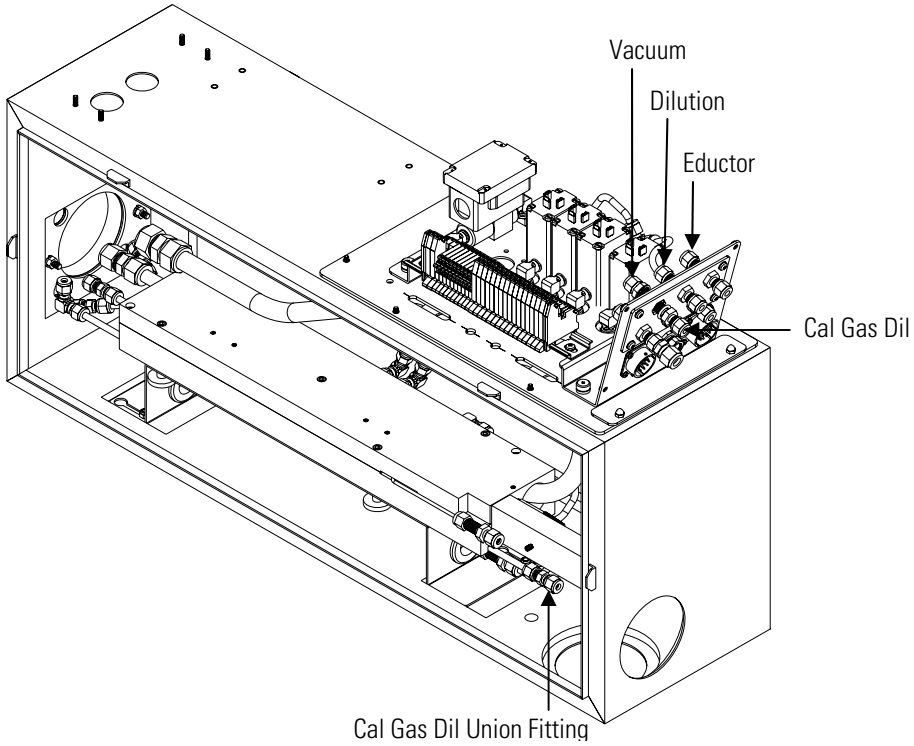


Figure 5–9. Fitting Locations – Umbilical Connections

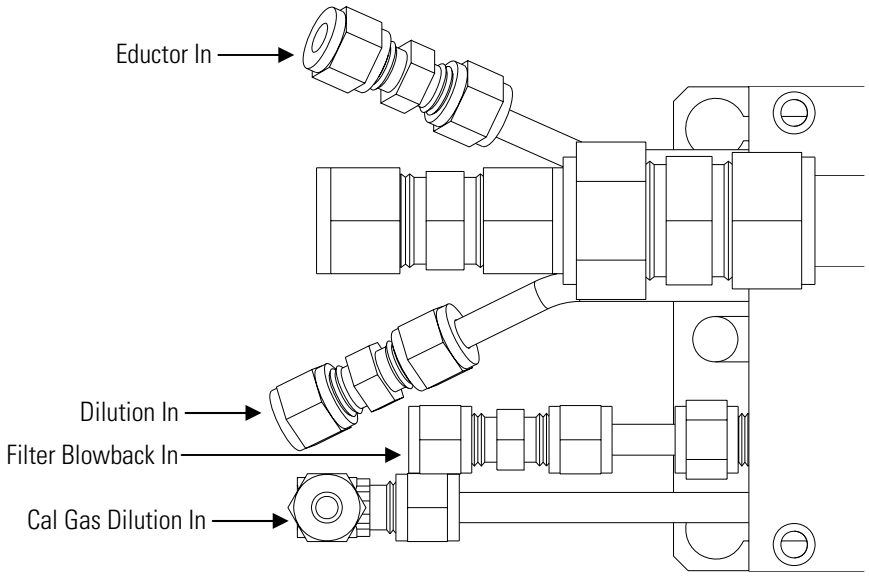


Figure 5–10. Fitting Locations – Fast Loop Assembly Flange End

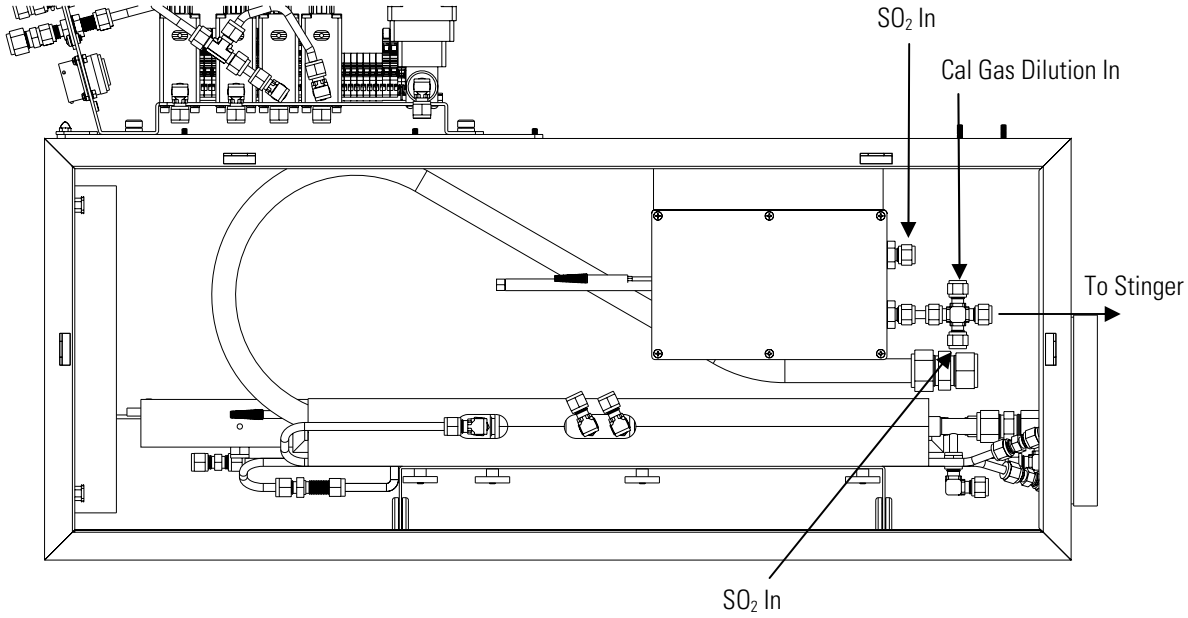


Figure 5–11. Fitting Locations – Generator

Factory Wiring

Figure 5–12 and Table 5–5 through Table 5–7 shows the factory wiring and wiring terminations for the Model 9805 Probe.

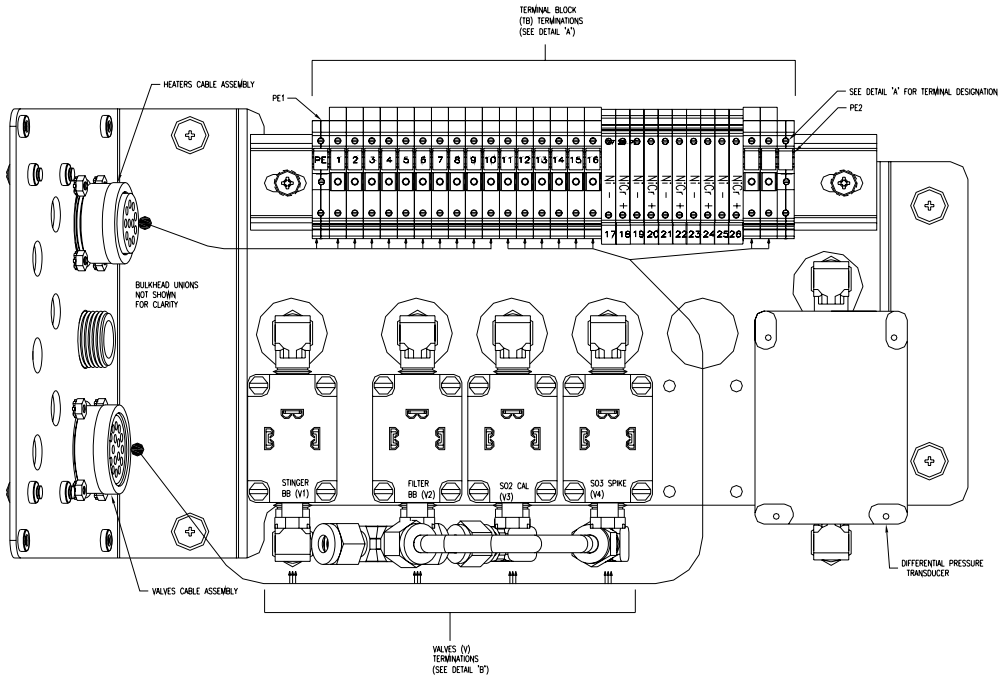


Figure 5–12. Factory Wiring – Terminal Block Terminations

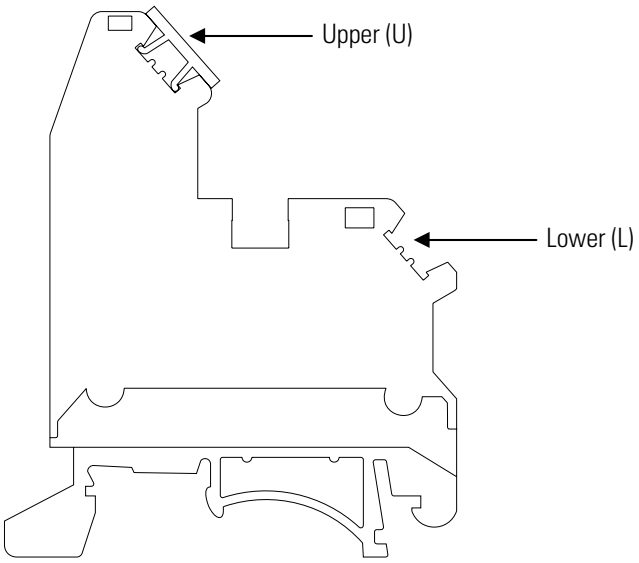


Figure 5–13. Terminal Block Terminations

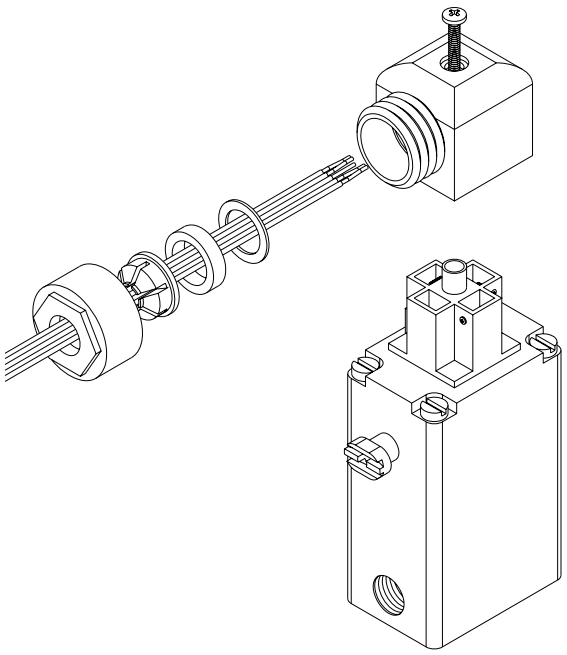


Figure 5–14. Valve Terminations

Table 5–5. Heaters Cable Assembly Terminations

From	Wire Color	To Terminal Block	Function
A	Grn/Yel	PE1(L)	Earth Ground
B	Red	1(L)	H1 & H2 (Probe)
C	Red	2(L)	H1 & H2 (Probe)
D	Blk	3(L)	H3 (Orifice)
E	Blk	4(L)	H3 (Orifice)
F	Brn	5(L)	H4 (Generator)
G	Brn	6(L)	H4 (Generator)
H	Blu	7(L)	H5 (Stinger)
J	Blu	8(L)	H5 (Stinger)
K	Vio	9(L)	H6 (Spike)
L	Vio	10(L)	H6 (Spike)

Table 5–6. Valves Cable Assembly Terminations

From	Wire Color	To	Function
A	Yel	All Valves	Line V
B	Grn/Yel/18	All Valves	Earth Ground
C	Vio/18	V1-2	V1 Return
D	Blu/18	V2-2	V2 Return
E	Gry/18	V3-2	V3 Return
F	Org/18	V4-2	V4 Return
G	Blk/20	TB-27(L)	DPX (-)
H	Wht/20	TB-28(L)	DPX (+)
J	Red/20	TB-15(L)	Spare (-)
K	Grn/20	TB-16(L)	Spare (+)
L	Not Used	-	-
M	Blk/18	TB-11(L)	Spare
N	Wht/18	TB-12(L)	Spare
P	Red/18	TB-13(L)	Spare
R	Brn/18	TB-14(L)	Spare
S	Not Used	-	-

Table 5–7. Differential Pressure Transducer Terminations

From	Color	To
Comm	Black	TB-27(U)
Exc	White	TB-28(U)

Dilution Eductor Replacement

Use the following procedure to replace the dilution eductor (Figure 5–15).

Equipment Required:

Dilution eductor

Open-end wrenches, 1/2-inch and 9/16-inch

Allen wrench, 5/32-inch

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Disconnect associated plumbing.
2. Remove five (5) sets of 10-32 cap screws/thumbnuts.
3. Remove fast loop top block with or without orifice locks attached.
4. Loosen three (3) fast loop table nylon insert nuts and slide table back.
5. Using a 1/2-inch and 9/16-inch open-end wrench, disconnect the dilution eductor.
6. Replace the dilution eductor and reassemble in reverse order.

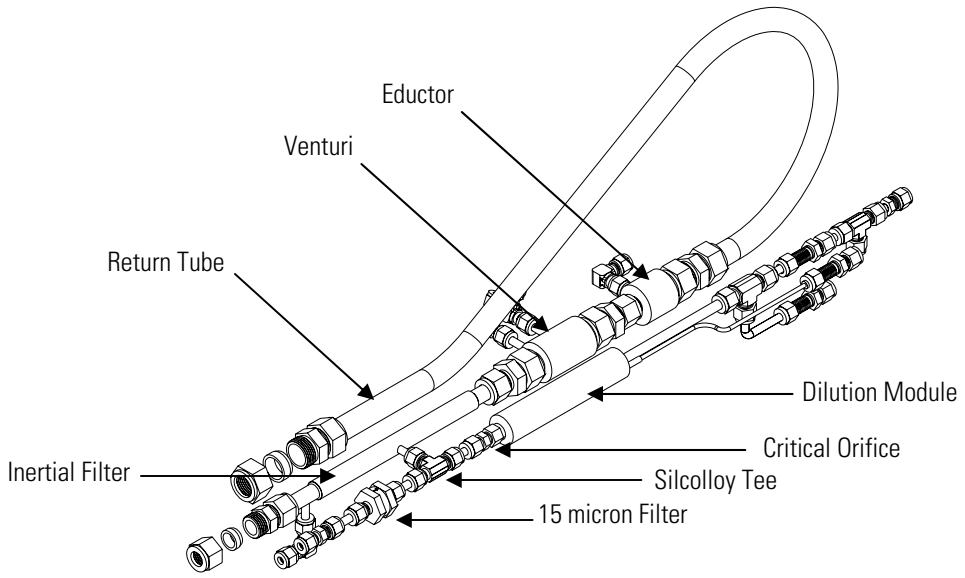


Figure 5–15. Fast Loop Replacements

Note When replacing parts, use appropriate open-end wrenches and make orientation of part. ▲

Inertial Filter Replacement

Use the following procedure to replace the inertial filter (Figure 5–15). Replace only after the probe has cooled, or use heat resistant gloves.

Equipment Required:

Inertial filter

Open-end wrenches, 1-1/8-inch, 1-1/16-inch, 7/8-inch, and 9/16-inch

Allen wrench, 5/32-inch

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Using a 1-1/8-inch and 1-1/16-inch open-end wrench, disconnect Return Tube.

2. Using a 1-1/16-inch and 7/8-inch open-end wrench, disconnect stinger tube from the inertial filter.

3. Remove 5 sets of 10-32 cap screws/thumbnuts.

4. Remove fast loop top block with or without orifice blocks attached.

5. Loosen three (3) fast loop table nylon insert nuts and slide table back.

6. Using a 1-1/16-inch, 7/8-inch, and 9/16-inch open-end wrench, replace the inertial filter and reassemble in reverse order.

Dilution Assembly Critical Orifice Replacement

Use the following procedure to replace the critical orifice (Figure 5–15).

Equipment Required:

Critical orifice

Open-end wrenches, 1-1/8-inch, 1-1/16-inch, 7/8-inch, and 9/16-inch

Allen wrench, 5/32-inch

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Using a 1-1/8-inch and 1-1/16-inch open-end wrench, disconnect Return Tube.

2. Using a 1-1/16-inch and 7/8-inch open-end wrench, disconnect stinger tube from the inertial filter.

3. Remove 5 sets of 10-32 cap screws/thumbnuts.

4. Remove fast loop top block with or without orifice blocks attached.

5. Loosen three (3) fast loop table nylon insert nuts and slide table back.

6. Using a 1/2-inch and 9/16-inch wrench, remove critical orifice.

Note Contaminated orifices that are removed can be ultrasonically cleaned using a non-base solution. PH must not be greater than 8. ▲

7. Replace with new or cleaned orifice. Ensure that these are no leaks as this will cause measurement errors.

15 Micron Filter Replacement

Use the following procedure to replace the 15 micron filter (Figure 5–15).

Equipment Required:

15 Micron filter

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Disconnect associated plumbing.
2. Remove 5 sets of 10-32 cap screws/thumbnuts.
3. Remove fast loop top block with or without orifice locks attached.
4. Loosen three (3) fast loop table nylon insert nuts and slide table back.
5. Replace the 15 micron filter seated flat with the arrow on top pointing at the cross union and assemble in reverse.

Valve Cover Gasket Replacement

Use the following procedure to replace the valve cover gasket (Figure 5–16).

Equipment Required:

Valve cover gasket

Extra long nut driver, 5/16-inch

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Perform shut down of the system. Refer to "Shutdown Instructions" in this chapter.
2. Turn off air supply to the instrument.
3. Remove acorn nuts from cover and screws to face plate.

4. Label and disconnect all valve fittings from valves going through top of probe.

5. Label and disconnect all heaters and thermocouples going through top of probe.

6. Set assembly aside without removing umbilical connectors.

7. Peel off face gasket and replace.

8. Replace the new cover gasket by following the previous steps in reverse.

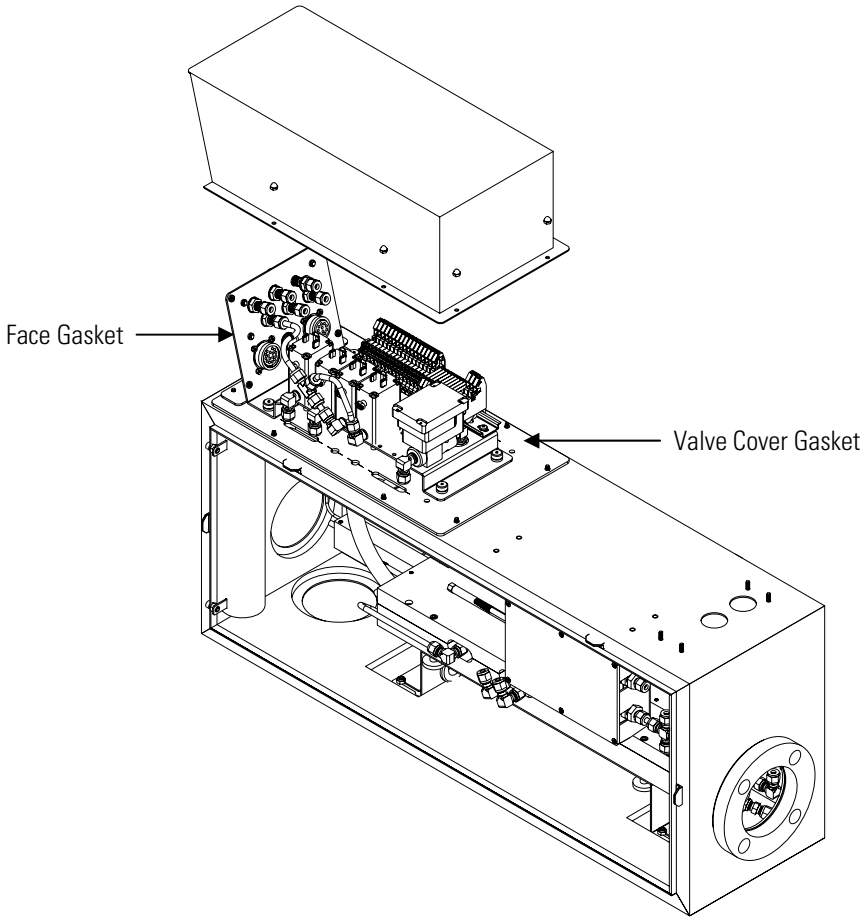


Figure 5–16. Cover Removal

Valve Assembly Replacement

Use the following procedure to replace the valve assembly (Figure 5–17).

Equipment Required:

Valve assembly

Extra long nut driver, 5/16-inch

Medium slotted screwdriver

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Remove electrical access cover. The cover is a convenient place to keep parts while working on the probe.

2. Identify which valve is to be replaced (labels on probe).

3. Using a medium size slotted screwdriver, remove four (4) M4x10 metric screws and lock washers from inside the probe. Retain.

4. Loosen screws and unplug electrical connector on top of valve. Refer to Figure 5–12 on page 5-19.

5. Install replacement valve in same orientation and reassemble in reverse order.

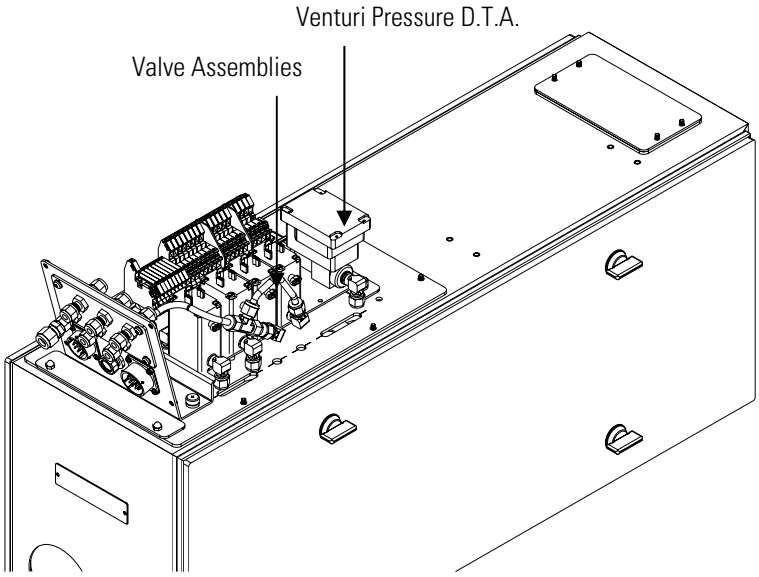


Figure 5–17. Electrical Components Replacement

Venturi Pressure Differential Transducer Assembly Replacement

Use the following procedure to replace the venture pressure differential transducer assembly (Figure 5–17).

Equipment Required:

Venturi pressure differential transducer assembly

Extra long nut driver, 5/16-inch

Nut drive, 1/4-inch

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Using a 5/16-inch extra long nut driver, remove six (6) acorn nuts. The cover is a convenient place to keep parts while working on the probe.

2. Disconnect tubing and wiring. Refer to "Factory Plumbing" on page 5-16 and "Factory Wiring" on page 5-19.

3. Using a 1/4-inch nut driver, remove the two (2) mounting screws holding the transducer to it bracket.

4. Replace transducer assembly and reassemble in reverse order.

Stinger Heater Replacement

Use the following procedure to replace the stinger heater.

Equipment Required:

Stinger heater

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Turn off stinger, probe, generator, and orifice heaters. Let the probe cool to a safe handling temperature.

2. After probe has cooled turn off air supply.

3. Snip any wire clamps holding heater cables in place. Disconnect wiring from position 7 and 8 (heater wires) and 23 and 24 (thermocouple

wires) from probe terminal block. Pull disconnected wires into probe. The wires need to be free before disconnecting probe from mantle. See Figure 2–7 and Table 2–2.

4. Disconnect Return Tube and Sample tube. Loosen the 3 nylon nuts that secure the fastloop table to the enclosure and slide it away from the Stinger.

5. Remove probe assembly from mantle and set aside.

6. Remove heater with a counter clockwise twist.

7. Install new heater and reassemble in reverse order.

Stinger Clamp Replacement

Refer to Figure 2–8 on page 2-9 to replace the stinger clamp. This is only necessary for lengths of 2 feet or more past the mantle exit.

Eductor Replacement

Refer to Figure 5–15 on page 5-23 to replace the eductor.

Venturi Tube Replacement

Refer to Figure 5–15 on page 5-23 to replace the venturi tube assembly.

SO_3 Generator Replacement

Use the following procedure to replace the SO_3 generator.

Equipment Required:

Nut driver, 3/8-inch

9/16-inch combination wrench

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

1. Remove probe doors.

2. Turn OFF generator heater and allow to cool to ambient temperature.

3. Disconnect heaters 5 and 6 and thermocouple 21 and 22 leads from top. Pull wires through bottom.

4. Remove the four nuts holding the generator bracket to the bottom of the probe case.

5. Loosen and remove both the inlet and outlet tubing from the generator.

6. Remove generator assembly.

7. Replace the generator and reassemble in reverse order.

Service Locations

For additional assistance, Thermo Fisher Scientific has service available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www. thermoscientific.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 6
Troubleshooting

This chapter provides the following troubleshooting and service support information for the Model 9800.

- "Instrument Devices and Alarms" on page 6-2
- "Instrument Board and Cable Assembly Connections" on page 6-10
- "Instrument Pneumatic Assembly Cables" on page 6-21
- "Probe Pneumatic, Cable and Wiring Connections" on page 6-22
- "Cable Assembly Connections (Heaters, Valves, and Optical Bench)" on page 6-26
- "Finding and Optimizing the Correct SO3 Peak" on page 6-27
- "Service Locations" on page 6-33

The Technical Support Department at Thermo Fisher Scientific can also be consulted in the event of problems. See "Service Locations" at the end of this chapter for contact information. In any correspondence with the factory, please note both the serial number and program number of the instrument.

Instrument Devices and Alarms

The following outline addresses possible instrument and alarm problems and proposes checks and possible troubleshooting solutions.

SO_3 Concentration

Low Concentration

- Leaks
  - Check Probe tubing for melted and cut sections.
  - Check for loose fittings
- Cold Spots
  - Ensure proper insulation at both ends of the hotline.
- SO_3 Generator needs Conditioning
  - The SO_3 Generator should be conditioned at least once a week. An automatic schedule can be created at the screen Service > SO_3 Generator Conditioning
- Detector not seeing enough light
  - Go to the screen Data Analysis > Real Time Spectrums > Raw Spectrum. If the y-axis maximum number is 0.20 or less, then the detector is not getting enough light. Laser and/or detector placement may need to be adjusted. Before doing that, shut down and reboot the system and see if the problem gets fixed. Allow 6 to 7 minutes for the laser power to turn ON.

High Concentration

- Go to the screen Data Analysis > Real Time Spectrums > Raw Spectrum. Ensure that the y-axis maximum number is between than 0.3 and 1.0. If it is not, go to the screen Service > Laser Controls > Laser Voltage. If the maximum y-axis number is below 0.3, increase the laser voltage in 1% increments. Do not exceed 9.0 volts.

Concentration Not Updating

- Laser and Detector Power
  - Ensure that the Laser and Detector Power, found at Instrument Controls > Component Power > Instrument – Laser and Detector Power, is ON. The Laser Housing Cooler and Laser Cooler will need to be ON before the Laser and Detector Power can be turned ON.

- Laser Housing Cooler and Laser Cooler are not on or have temperature alarms.
- Check for loose cables at the Laser, Detector and Detector board.
- If communication is lost at the detector, the transmissions spectrum and raw spectrum screens will not update. Also, the SO_3 concentrations will not update. A shutdown and reboot may be needed.

Calibration

Automatic Calibration Schedule Failure Modes – If a failure occurs a failure message will appear at the screen, Calibration > Auto Calibration Schedule, under the "Peak Adjust" button.

- Failure 1 – Zero Bkg Out Of Range During SZ
  - The allowable Zero Background range is -100 to 100 ppm. If, during the zero duration of an automatic calibration, the Zero Background is set to outside this range, then the auto calibration sequence will stop and both the original background and span coefficient will be restored.
- Failure 2 – Current Span Coef Denominator = 0
  - This failure will be displayed if any of the variables in the Span coefficient equation creates a 0 in the denominator. The Error should not happen during normal operation. Both the original background and span coefficient will be restored.
- Failure 3 – Span Coefficient Out Of Range
  - The allowable Span Coefficient range is 0.5 to 2. If, during a calibration, the Span Coefficient is set to outside this range, then the auto calibration sequence will stop and both the original background and span coefficient will be restored.
- Failure 4 – Prev Span Coef Denominator = 0
  - This failure will be displayed if the Previous Span Coefficient equals zero. The Error should not happen during normal operation. Both the original background and span coefficient will be restored.
- Failure 5 – Zero Bkg Out Of Range during SS
  - The allowable Zero Background range is -100 to 100 ppm. If, during the span duration of an automatic calibration, the Zero Background is set outside this range, then the auto calibration sequence will stop and both the original background and span coefficient will be restored.

- Failure 6 – Span Peak Too Weak During SS
  - If during an automatic calibration the SO_3 peak is considered too weak, then the calibration will stop and the original zero background and span coefficient will be restored.

SO_2 Cylinder

- Check to see that the secondary stage of the tank regulator is opened and reading at least 40 psig, and that the tank is not near empty.
- The balance gas of the SO_2 cylinder must be air. The SO_3 generator will not work properly if any other balance gas is used.

Eductor Air Flow

- In order for the system to be calibrated properly, the flowrate of the calibration gas must exceed the flowrate of the sample gas being pulled into the probe via the eductor. If the span is unstable or does not appear consistent from one calibration cycle to the next, adjust the eductor pressure either up or down until the span response is highest and stable. The default Eductor Pressure is 2 psig, and the flowrate of the calibration gas should be at least 3 LPM.

Plugged Orifice

- If the system does not respond to SO_3 and there are no spectral features on the Transmission Spectrum Screen at 100 ppm, switch to SO_2 Mode (under the Service screen) and look for any SO_2 spectral features. If no peaks are observed then the critical orifice may be plugged. See "Dilution Assembly Critical Orifice Replacement" on page 5-24. Assuming the rest of the system is working properly and there are no leaks, put the system in Blowback mode, and turn the Dilution Pressure off, turn the Pump off (switch is located on the pump), and turn the Probe Heater "off". Let he probe cool down, remove the clamshell insulation and remove the 5 thumbscrews that clamp the top half of the clam shell to the bottom half. Remove the orifice which is 1.5-inch long, located between the inertial filter Tee fitting and the Dilution module. Replace or sonically clean the orifice (with DI water). Before replacing, hold up the new or cleaned orifice to the light and ensure that a pinhole is visible before replacing. Reassemble the clam shell and insulation; turn the Probe Heater back on. Turn the probe back on only once the probe temperature returns to Setpoint. Place system in SO_2 span mode and look for spectral features.

Temperature, Cold spot

- Cold spots will allow for SO_3 adsorption resulting in low concentrations in the optical bench. Possible cold spots include all areas where SO_3 travels but in particular at either end of the heated umbilical tubing. Ensure that each end of the hotline umbilical is heated and insulated sufficiently to maintain temperatures greater than 180 °C.

Generator Bakeout

- If, at the end of the span duration, the span concentrations readings are low, the SO_3 Generator may need to be conditioned. This cleaning can be automatically performed using the SO_3 Generator Schedule. The temperature of the Generator will be increased to 580° for at least a half hour. At the end of the schedule, the generator temperature will be set back to the setpoint temperature. It is recommended to run Generator Conditionings every other day or at least once a week.

Plugged Stinger

- If all other troubleshooting attempts do not correct the problem of low or no SO_3 response, it may be that either the inlet or outlet stinger is plugged. This may be a stronger possibility if the probe was left in the duct or stack while cold. See "Stinger Heater Replacement" on page 5-28.

System Coefficient

- If the system coefficient continually increases, it is possible that less and less SO_3 is making it to the optical bench. Generator bakeouts may need to be performed more readily.
- If during a calibration, the span coefficient is attempting to set a value outside of the 0.5–2.0 range, the System Coefficient may need to be adjusted.

Bench Temperature

No Reading

- Check thermocouple and heater wire connections.

Bench Pressure

No Reading

- Check hotline umbilical tubing connections at both ends—the bench connection and the probe connection.

High Reading

- The Pump may need to be replaced if it has been in use for over 1 year.

Chassis Temperature

Air Conditioner

- If the chassis temperature exceeds the maximum alarm setting, the system may not be able to keep the laser housing temperature low enough for proper operation. Check to see if the Air Conditioner discharge air is cold to the touch in the case of an excessively high chassis temperature. If the discharge air is not cold (<20c) after 25 minutes, the air conditioner may need to be serviced or replaced.
- It is imperative that the chassis door stay closed while the air conditioner is on (unless you are actively troubleshooting some inside the instrument).
- The SO_3 instrument has an over-temperature snap switch (manually resettable) located on the AC Mains bracket. If the chassis temperature exceeds 120 °F, the snap switch will open and cut the a/c power to the heater until the switch is manually reset.
- There is a second snap switch associated with the Air Conditioner. When the chassis temperature reaches 140 °C, power to the Air Conditioner is shut off until the switch is manually reset.

SO_2 MFC Cal Flow

No SO_2 Flow

- If there is no SO_2 flow during System Span, Auto System Span or SO_2 mode, then check that both the SO_2 span cylinder and regulator are open.
- Check that the SO_2 valve atop the probe is activated during the above stated gas modes.

Span MFC Dilution Air Flow

No Span Dilution Air Flow

- If there is no air flow for the span gas dilution air during the gas modes: System Zero, Auto System Zero, System Span, Auto System Span and SO_2 mode, ensure that the air handling system is functioning correctly. See *Air Handling Manual* (P/N 110329-00).
- Check that the dilution air valve atop the probe is activated during the above stated gas modes.

Span Reading

Not getting to Span Setting Concentration

- If the Span Reading found at Systems Status and Alarms > Instrument, is alarming during System Span or Auto System span then the MFC's may not be functioning correctly. See SO_2 MFC Cal flow and Span MFC Dilution air Flow above.

Laser Power

Laser Power not turning on

- The Laser/Detector power can be turned on at the screen Instrument Controls > Component Power > Instrument. Before the Laser/Detector power can be turned on, both the Laser housing cooler and Laser cooler must be ON and their temperatures within their respective alarm limits.
- Ensure that all connections, especially coaxial cables, to the laser, detector and detector board are tight.

Laser Temperature

Laser Temperature not reaching Setpoint Temperature

- When the Laser Cooler is turned on, the Laser Cooler temperature will automatically step down in temperature until reaching the setpoint temperature. This should take 5–7 minutes. This also will happen automatically when the user boots up the instrument. The Laser temperature should not be set to a temperature greater than 25 °C.
- If the Laser Temperature takes a long time to reach the setpoint temperature then ensure that the laser housing temperature is maintaining its setpoint temperature.
- If the Laser Cooler does not cool the laser to its setpoint temperature, then the peltier cooler may need to be replaced.

Laser Housing Temperature

Laser Housing Temperature not reaching Setpoint Temperature

- If the Laser Housing temperature cannot reach its setpoint temperature, ensure that the Air Conditioner is working properly. If the instrument is in a warm environment and the Chassis temperature is not being cooled and maintained then the Laser Housing Cooler may not be able to reach its setpoint temperature.
- If the Laser Housing cannot reach its setpoint temperature then the peltier coolers may need to be replaced.

Laser Voltage

Laser Voltage reading 0.

- The laser voltage should generally be set between 8-9 Volts. If there is a problem with the board or if the voltage goes to zero, reboot the instrument.

Etalon Effect

Sine Waves in the Transmission Spectrum affecting SO_3 Concentration

- If there are pronounced sine waves in the blue curve of the transmission spectrum, then marked noise will be prevalent in the concentration readings. Increasing the Laser voltage by 2 or 3 percent may get rid of this etalon effect.

Detector Power

Detector Power not turning on

- The Laser/Detector power can be turned on at the screen Instrument Controls > Component Power > Instrument. Before the Laser/Detector power can be turned on, both the Laser housing cooler and Laser cooler must be ON and their temperatures within their respective alarm limits.
- Ensure that all connections, especially coaxial cables, to the laser, detector and detector board are tight.

Detector Temperature

Detector Temperature not reaching Setpoint Temperature

- Ensure that all connections, especially coaxial cables, to the detector and detector board are tight.
- If communication is lost at the detector, the transmissions spectrum and raw spectrum screens will not update. Also, the SO_3 concentrations will not update. A shutdown and reboot may be needed.

Detector Peak

SO_3 Peak at the Transmission Spectrum Screen is outside the -5 to 5 Detector Peak Channel Range

- The detector peak, during system span, should be a large enough peak to be noticeable against the background noise. It should be centered around channel 0 at the screen, Transmission Spectrum. If it is outside the detector channel range of -5 to 5 then the laser cooler setpoint temperature will need to be changed. Note this is automatically done during an Automatic Calibration Schedule if the Peak Adjust option is selected.
- The SO_3 peak can be manually shifted towards channel 0 by manually changing the Laser Cooler setpoint temperature found in the menu System Status and Alarms. At the Transmission Spectrum screen, if, during system span, the SO_3 peak is located to the right of channel 0 (a positive Peak Channel number located at the bottom right of the screen) then the Laser Cooler Temperature should be decreased in temperature by 0.01 °C steps until the SO_3 peak is between Peak Channel numbers -2 and 2. If the SO_3 peak is located to the left of channel 0 (a negative Peak Channel number located at the bottom right of the screen) then the Laser Cooler Temperature should be increased in temperature by 0.01 °C steps until the SO_3 peak is between Peak Channel numbers -2 and 2. You will need to wait 30 to 60 seconds each time after changing the Laser Cooler setpoint temperature to see where the SO_3 peak settles before making another Laser Cooler setpoint temperature change.
- If the SO_3 peak is weak (just beyond the noise) then the SO_3 Generator Conditioning Schedule should be performed more often. Perhaps once every two days or even once a day. If, during an automatic calibration schedule, the SO_3 peak isn't greater than the noise, the schedule may be cancelled and the system will not be calibrated.

HVAC

Chassis Temperature is not maintaining temperature

- It is critical that the Air Conditioning unit is working, especially in warm environments. Open up the Instrument Chassis door and feel the coolness coming out of the air conditioner unit. In warm environments, the air should be cool to the touch. If this is not the case, or if the chassis temperature is below 15 °C and above 32 °C, then the HVAC unit may need to be serviced or replaced.

Network Connectivity

Cannot remotely connect to the Instrument

- See Appendix B, "ePort PC Software" for Eport connectivity.
- If using DHCP, the instrument must be connected to the network upon startup.

Pump

Bench pressure is greater than 28 inches mercury

- Nominally the pump should be rebuilt or replaced annually. To determine if the pump needs to be replaced, insert a vacuum gauge at the "Pump" bulkhead on the right side of the Instrument Chassis. Ensure that the pump is pulling greater than 28 inches mercury vacuum.

Instrument Board and Cable Assembly Connections

The following section describes the functionality of each of the computer boards. See Appendix D, "Error Code Troubleshooting" for Board Status and Error Codes.

System Control Board (Top of board)

- All thermocouple connections for both the instrument and the probe get plugged in at the top of this board. The corresponding labels are printed to the left of the connector. Ensure all connections are inserted properly. It is possible to verify correct thermocouple connection, by unplugging each thermocouple one at a time and use the System status and Alarms screen to see if the correspondig temperature reads "0.0"
- All transducers, pressure regulator and mass flow controllers (MFCs) plug into this board. All jacks are labeled.
- If it is determined that this board is faulty, replace with Part Number 109930-00.

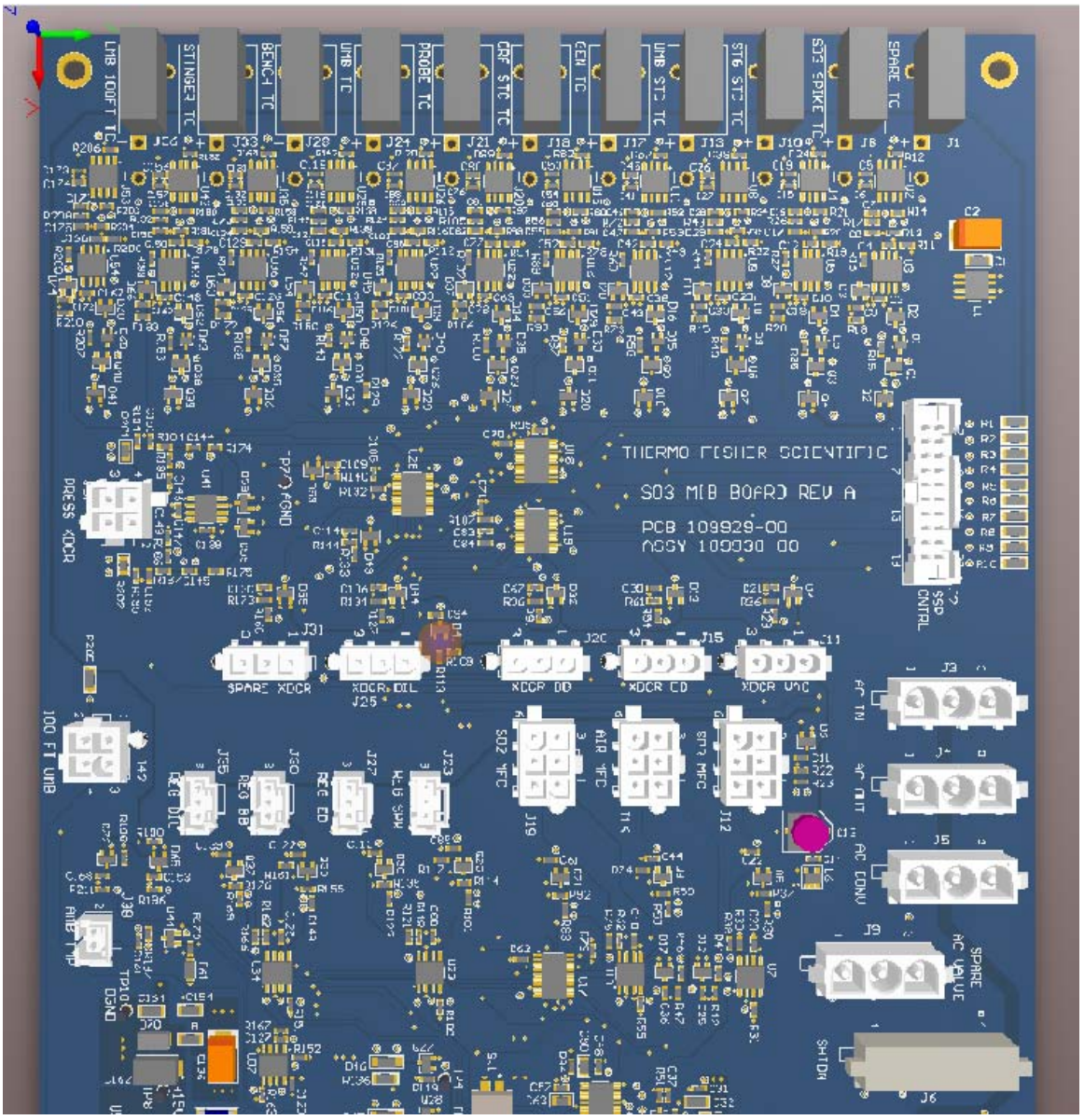


Figure 6–1. System Control Board (Top of board)

System Control Board (Bottom of board)

- There are 8 fuses on this board that correspond to the valves in both the instrument and probe. They are (from top to bottom) SO_3, SO_2, Blowback Filter, Blowback Stinger, Eductor, Dilution Air, Spare 1 (not used) Spare 2 (not used). If any of the corresponding valves are not functioning, it is either that the valve is miss wired, broken, or the corresponding fuse is blown.
- There are green LEDS below each fuse holder that light when that valve is supposed to be open. You can use these LEDS to ensure that

this board is receiving the correct “Gas Mode” valve selection assigned through the GUI.

- The 4 pin dc power connector J14 is located at the bottom of this board. Check voltages if a board problem is suspected.
- The two RS-485 connectors (J29 and J34) are located on the left side of this board. They are interchangeable and are used to daisy chain all the boards together. If you suspect a communication problem with this board, check these connections and associated cables, then verify under System Status and Alarms > Board Status that the communication is OK.

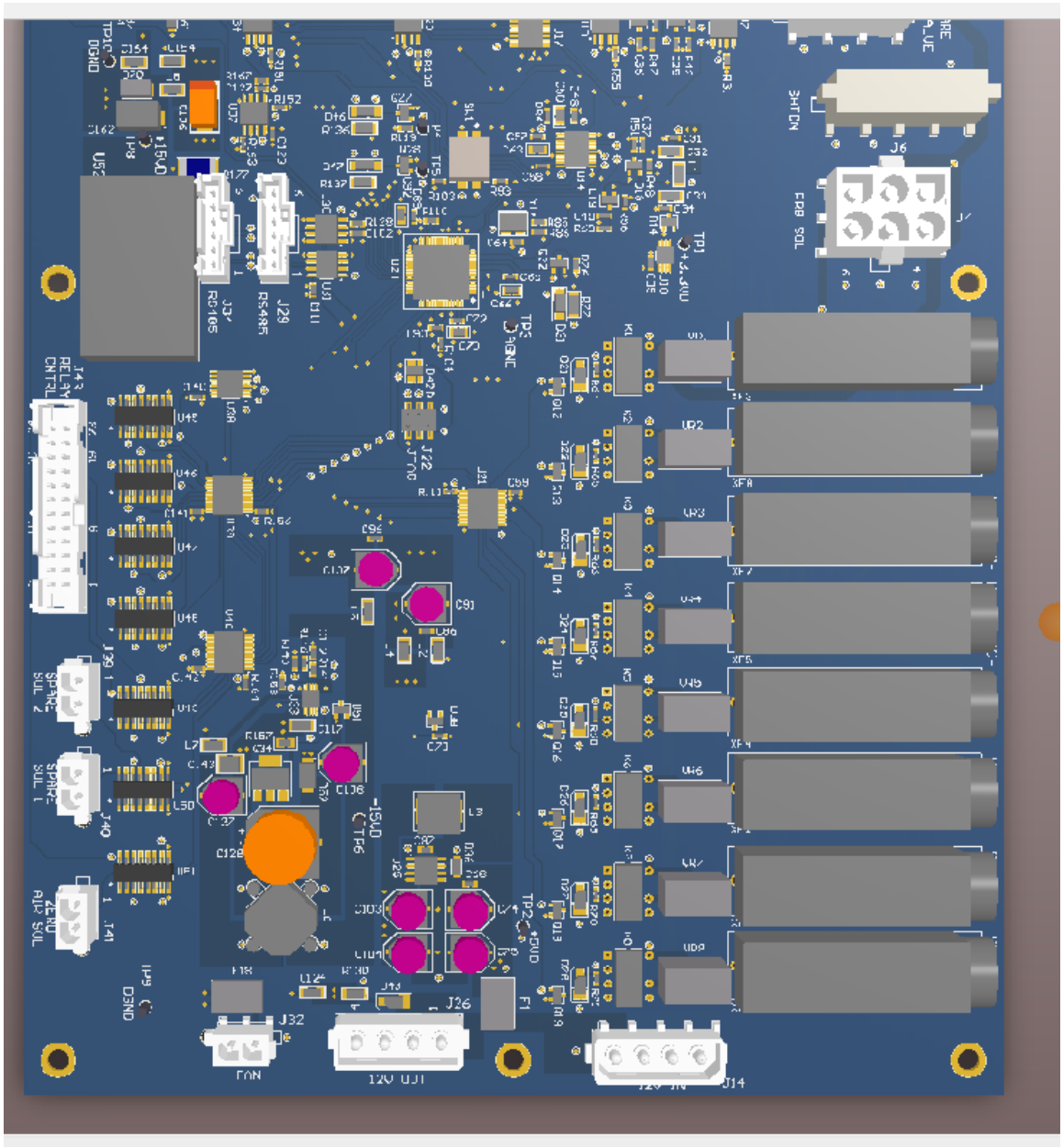


Figure 6–2. System Control Board (Bottom of board)

Laser and Laser Housing Temp Control Boards (Top of board)

- There are 2 temperature control boards used in the Arke System and they are identical. One controls the Laser Housing Temperature and the other controls the Laser Temperature. Both of these boards are mounted on left side of the User Interface Assembly. Each board has a dip switch which determines if it is the Laser or the Laser Housing control board. If the switch is pointing up (closest to the "Thermo" silkscreen) it is configured for the Laser Temperature control. If the switch is down (closest to the "Scientific" silkscreen) the board is configured for the Laser Housing temperature control. It is critical that this be configured correctly if the board is replaced.
- J6 is the 6 pin Jack that connects the board to either the laser or laser housing. The 2 pin connector in the upper right powers the fans for the laser housing and detector.
- If it is determined that this board is faulty, replace with Part Number 109918-00
- D4, on the right middle, is a Red LED that is lit when the cooler is set to "Off"
- D2 on the upper right of the board is a Yellow LED that lights when the actual temperature of the cooler is too far above the Setpoint.
- When the cooler circuit is driving above 50% power (usually this only happens when the cooler initially tries to reach it's setpoint, the blue LED D9 (located at the top of the board) turns ON. Under normal circumstances, this LED will tapper off as the setpoint is reached.

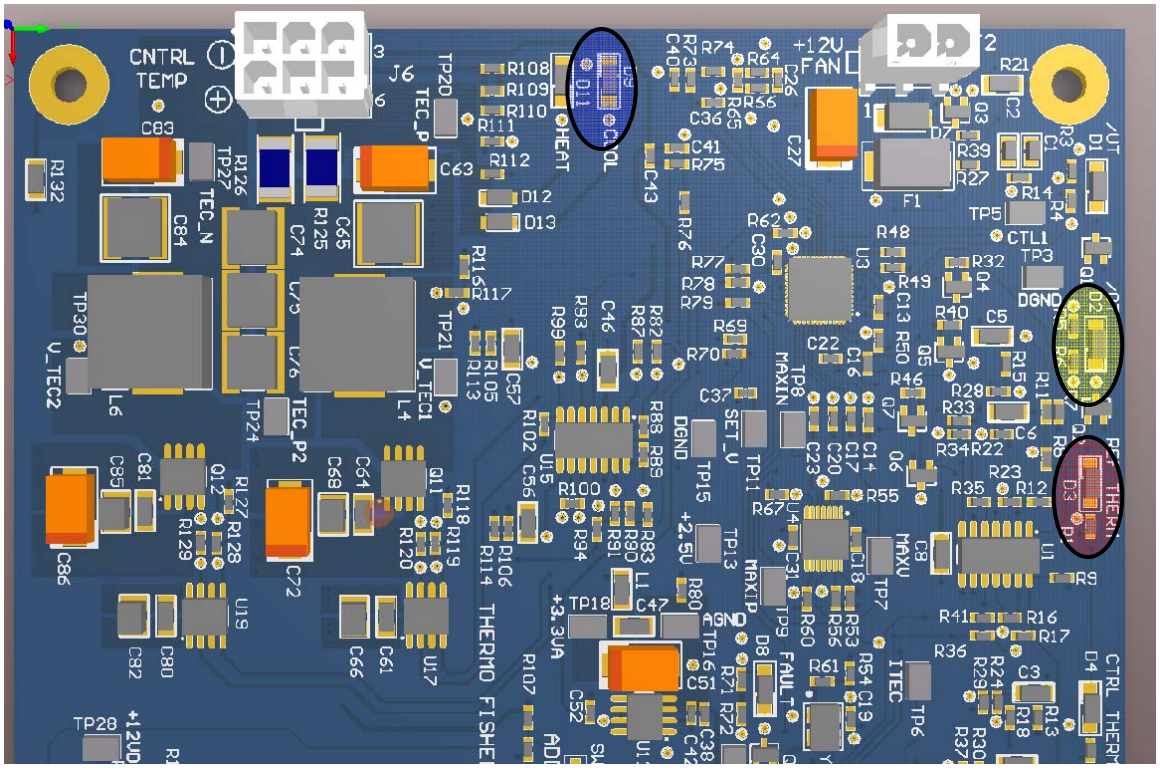


Figure 6–3. Laser and Laser Housing Temp Control Boards (Top of board)

Laser and Laser Housing Temp Control Boards (Bottom)

- D10 is a green LED that blinks when the board is communicating?
- The 4 pin dc power connector J7 is located at the bottom of this board. Check voltages if a board problem is suspected.
- The two RS-485 connectors (J3 and J4) are located on the left side of this board. They are interchangeable and are used to daisy chain all the boards together.

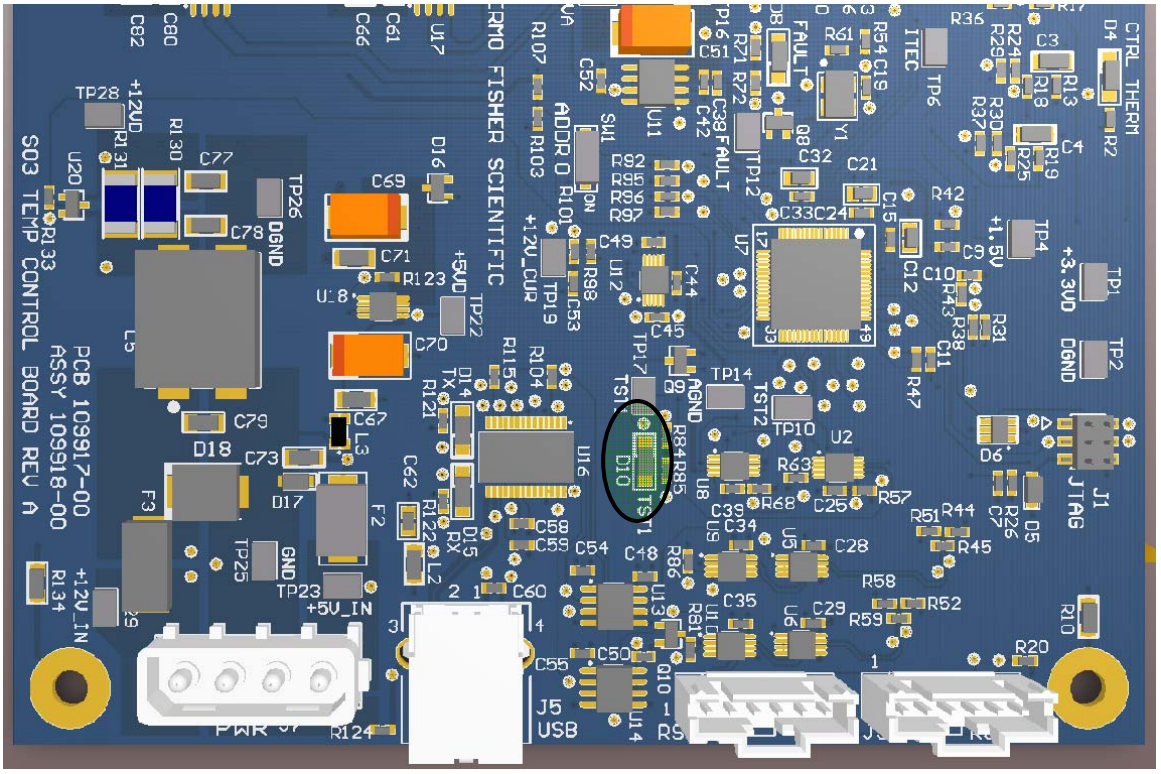


Figure 6–4. Laser and Laser Housing Temp Control Boards (Bottom of board)

Laser Connector Board

- If the Laser is not firing, check all connections to this board. This includes the coax cable going to CLK, the TEC connector, PWR connector and the two RS-485 connections.
- The cable that connects to J4 on this board should connect to the Laser Temperature control board which has the DIP switch in the Up position (closest to the “Thermo” on the silkscreen). It is important that these cables are not switched between the Laser Control board and the Laser Housing Small Connector Board.
- If it is determined that this board is faulty, replace with Part Number 110819-00
- The 4 pin dc power connector J5 is located at the bottom of this board. Check voltages if a board problem is suspected.
- The two RS-485 connectors (J7 and J8) are located on the left side of this board. They are interchangeable and are used to daisy chain all the boards together, however, this board usually is where the RS-485 terminates (only one cable)

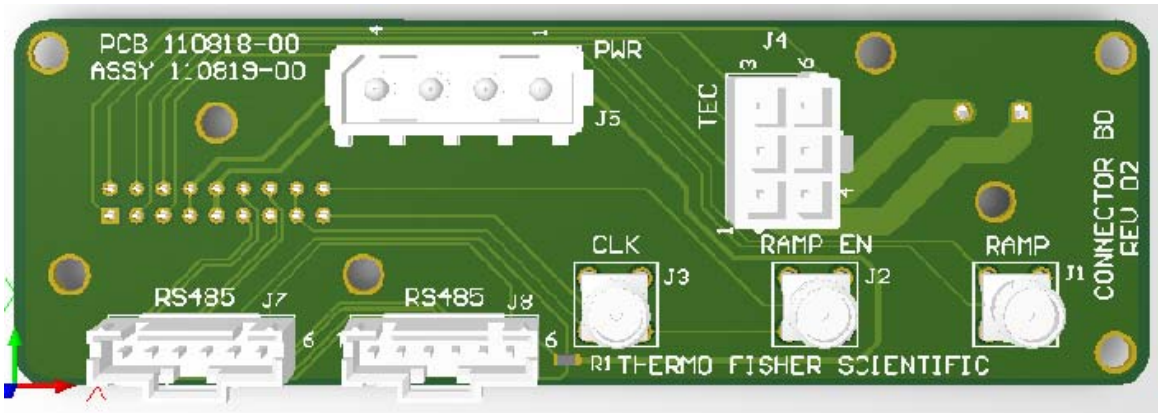


Figure 6–5. Laser Connector Board

Laser Housing Small Connector Board

- The cable that connects to J3 on this board should connect to the Laser Housing Temperature control board which has the DIP switch in the Down position (closest to the "Scientific" on the silkscreen). It is important that these cables are not switched between the Laser Control board and the Laser Housing Small Connector Board.

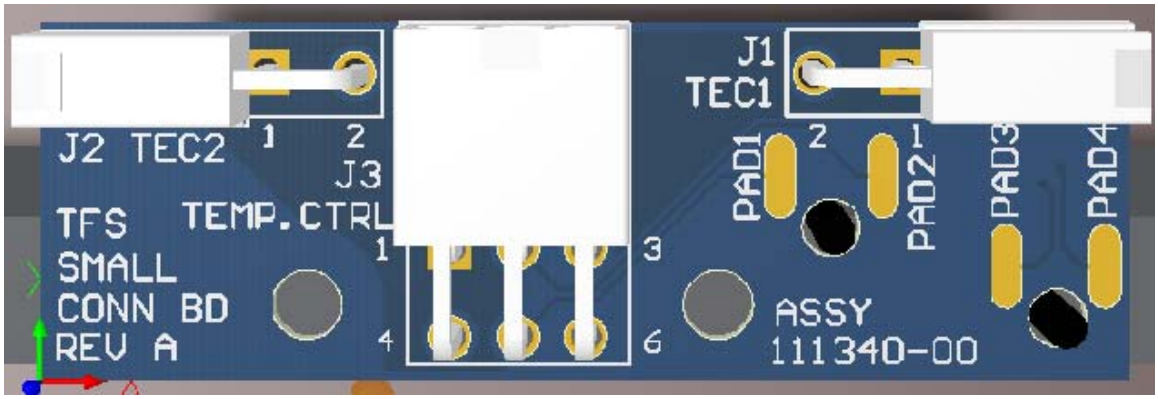


Figure 6–6. Laser Housing Small Connector Board

Detector Board (Top of board)

- If the Laser and Detector Power is set to ON (under Component Power) the 2 highlighted "Active" LED lights should blink OFF/ON alternately. If the spectrum is not updating, and the Laser and Detector Power is reading OFF (under Component Power), a power cycle may be necessary
    - Ensure that the Laser and Detector power, located at the screen Instrument Controls > Component Power > Instrument – Laser and Detector Power, is turned ON.

- If the “Active” LEDs are not blinking ON/OFF every 10 to 30 seconds then ensure power and communication cables are connected. Ensure the detector power cable and the 2 coax cables are connected tightly at both ends of the cable.

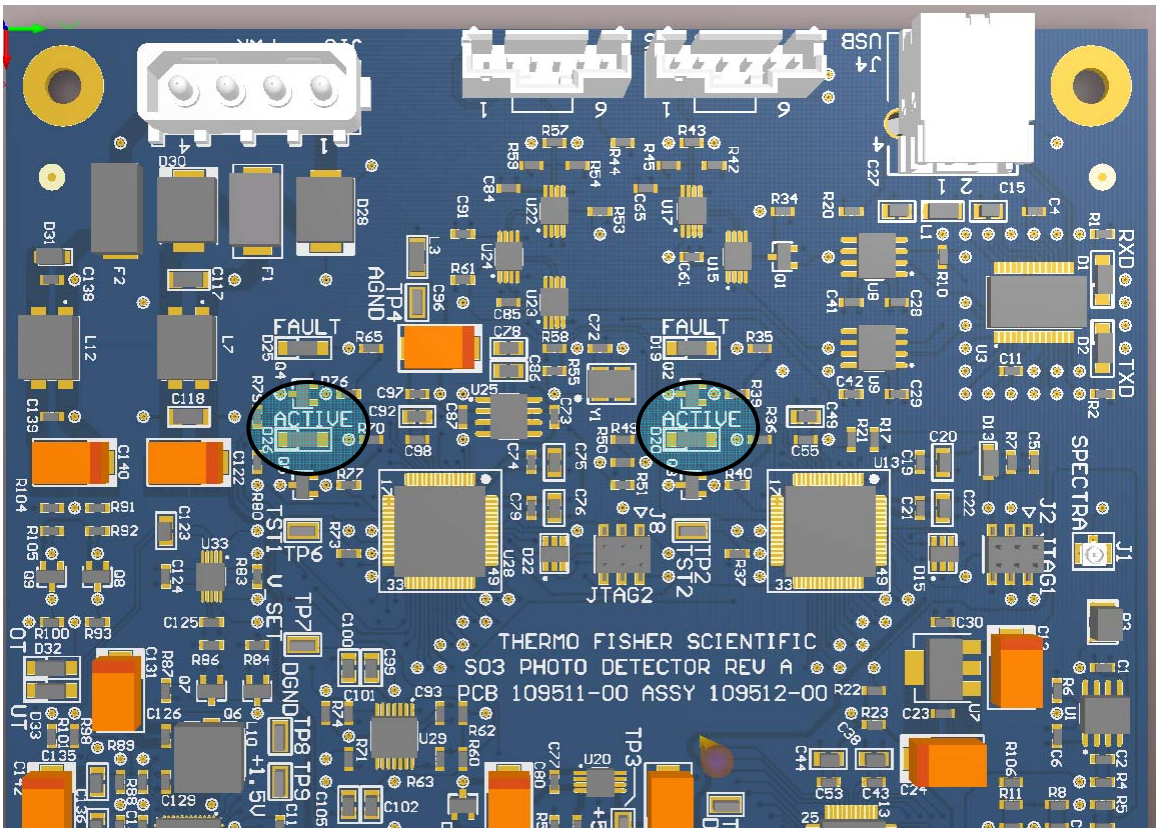


Figure 6–7. Detector Board (Top of board)

Detector Board (Bottom)

- Detector Temperature Status LED
  - Located at the left of the board, the LED, D32 will be lit blue if the detector temperature is over the Setpoint value. The LED, D33 (below D32) will be lit blue if the detector temperature is under the Setpoint temperature.
- Detector Cooler drive
  - There are two LEDs at the bottom-left of the board. When the Detector cooler is on, the right LED will be lit. If the Detector needs to be heated the right LED will be lit.
- The cable that is connected to J11 should be connected to the Detector.

- Light Intensity LEDs. The detector board's row of LEDs, located on the bottom right corner of the board, show the intensity of the light hitting the detector. At least 3 of the 10 LEDs should be lit when the Laser and Detector are ON.
    - If none of the LEDs are lit
        - Ensure Laser/Detector component power is ON.
        - Ensure Detector Cooler component power is ON.
        - Ensure Detector Fan is plugged into either the laser board or laser housing board and is functioning properly.
        - Check to see if the two coax cables are tight at the board and at the detector and laser assemblies.
        - Ensure that the mini coax that is connected to the CLK connector is connected the connector labeled CLK on the Laser Board
        - Ensure that the mini coax that is connected to the Preamp connector is connected to the Detector.
        - Increase Laser Power at the screen: Service > Laser Controls > Laser Voltage Setpoint. Increase the percentage. Caution should be exhibited when exceeding a Laser Voltage of 9V.
        - At a last resort, loosen the hex screw that secures the detector mount and re-position the detector in front of the bench exit window.
    - If all the LEDs are lit, determine if it is due to light saturation or Detector Dark current, by blocking by inserting a piece of paper between the laser housing and the bench input window.
        - If the LEDS remain lit, when the light is blocked, ensure tat the Detector Cooler power is ON (Component Power)
        - If the LEDs go out decrease Laser Power at the screen: Service > Laser Controls > Laser Voltage Setpoint. Decrease the percentage. If decreasing the percentage by 2 or 4% doesn't change the number of LEDs lit, then set the percentage back to its original value as this is not the problem.

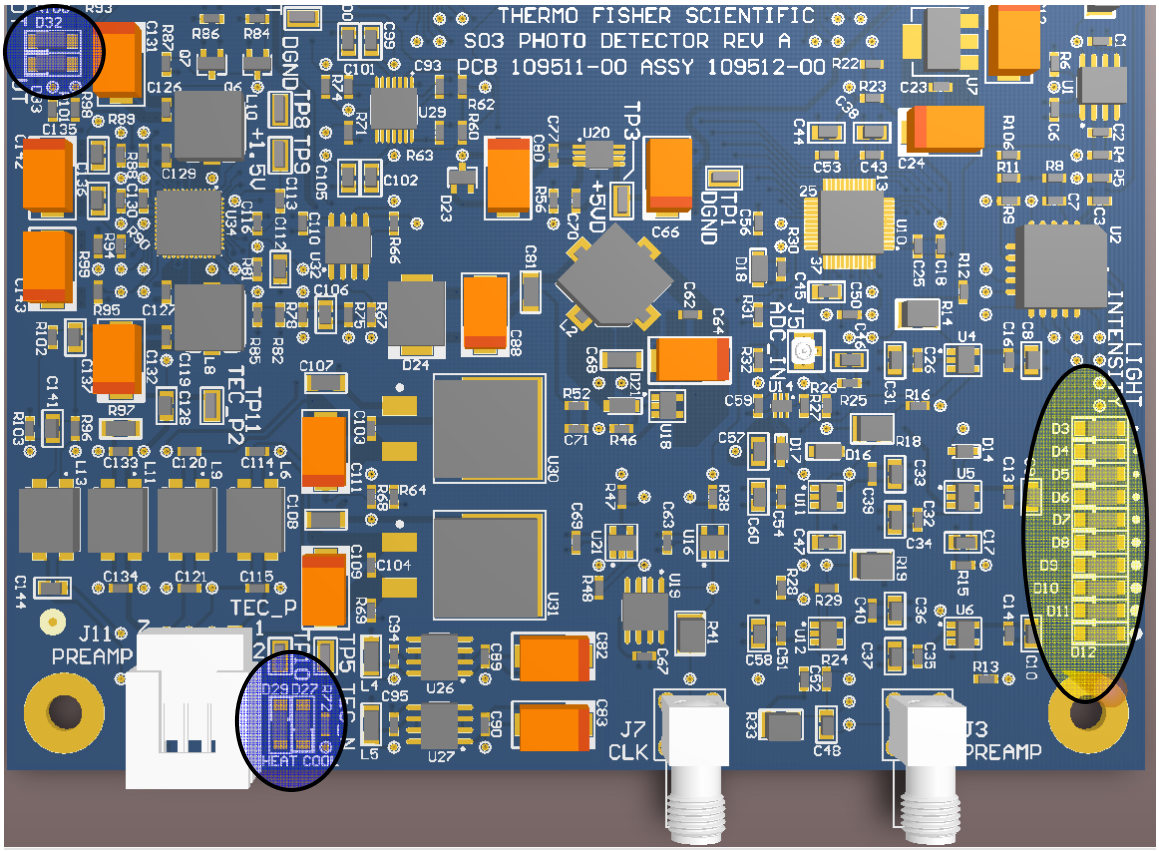


Figure 6–8. Detector Board (Bottom)

Motherboard

- RS-485 communication connectors, J8 & J9, are located on the right side directly below the white 3 pin connector. These two jacks are interchangeable and are daisy chained with the other boards.
- SATA Connections. There are 4 SATA Connections that may be used to connect to the hard drive. The default is J30 which is the top most left SATA connector.
- If the touch screen display does not have a backlight, ensure connection at J35 (4 pin connector) at the upper left corner of the board.
- There are two power connections. The main ATX power connection connects to the 24 pin connector at the upper right, J25. The second is the four pin connector located at J33.
- The Network jack on the front panel of the instrument should connect to the network jack closest to the blue VGA connector, J3.
- The USB port, J16, is used to connect the touch screen to the motherboard. It is the top 10 pin connector located on the right side.

- The USB port, J15, is used to connect the front panel USB drive to the motherboard. When a thumb drive is inserted and the system doesn't recognize it, ensure that it is connected properly. Some thumbdrives may not be compatible.
- If the display is lit and there is no communication, ensure that the ribbon cable is tightly fastened to J34 which is the 31 pin connector at the top left.

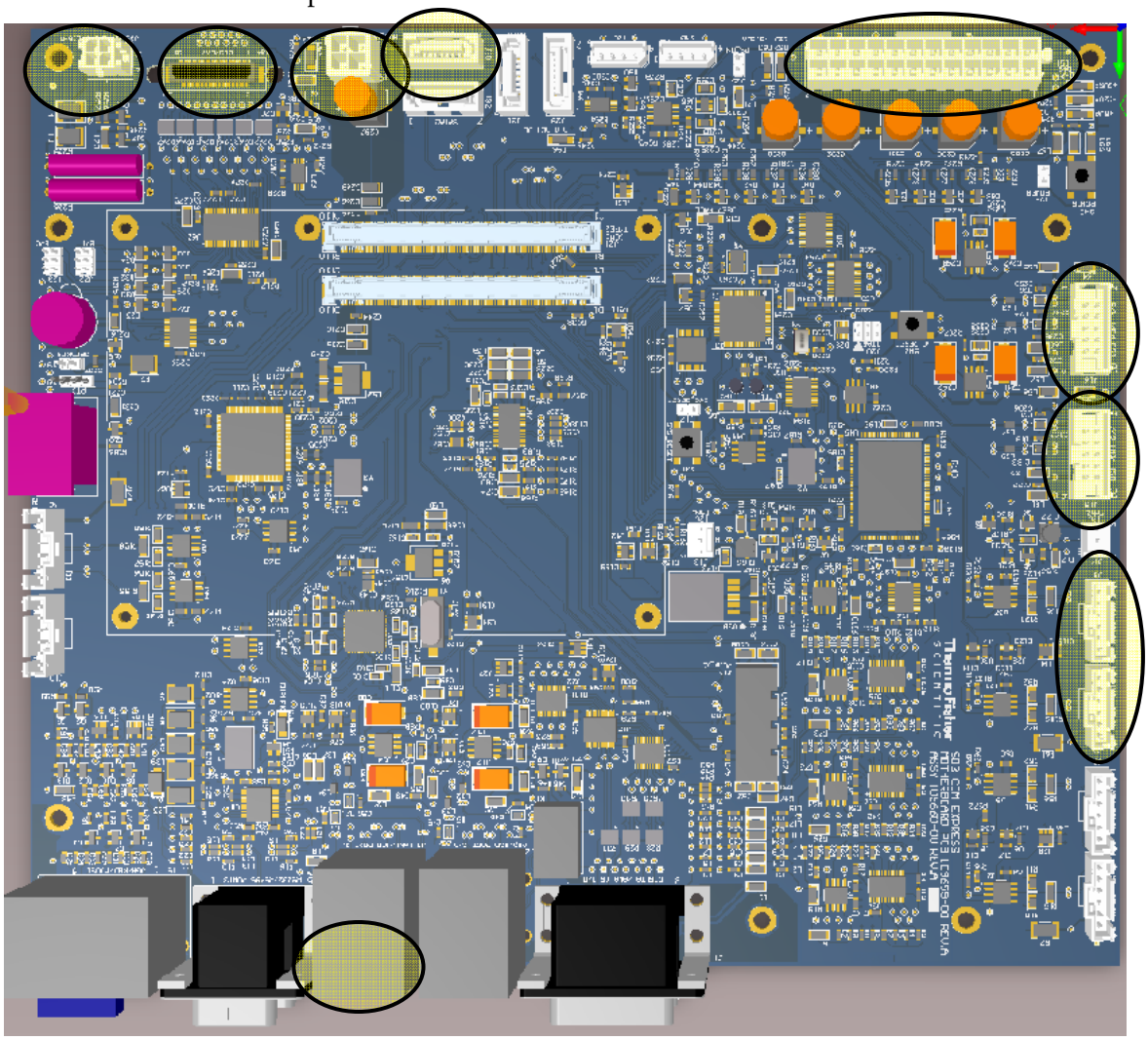


Figure 6–9. Motherboard

Instrument Pneumatic Assembly Cables

This section lists the Instrument's Pneumatic assemblies, part numbers, and board connections.

Detector, Laser, and Pneumatic Assembly Cables

See Table 6–1 for the Detector, Laser, and Pneumatic Assembly cables.

Table 6–1. Detector, Laser, and Pneumatic Assembly Cables

From	Description	To
Detector Assembly J2, J1	Item 8, 110977-00, Coax Cable	109512-00, J3
	110971-00, Preamp to Photo Detector	109512-00, J11
	Assembly, Fan, Detector	109918-00, 'A', J6
Laser Housing Assembly (Bottom Connector Bd) J4, TEC	Item 12, 6-Pin, 111019-02	109918-00, 'A', J4
Laser Housing Assembly (Bottom Connector Bd) J3, CLK	Item 8, 110977-00, Coax Cable	109512-00, J7
Laser Housing Assembly (Top Connector Bd) J3	Item 13, 110019-01, 6-Pin	109918-00, "B", J4
Laser Housing Assembly (Bottom Connector Bd) J8, RS-485	Item 14, 51-010803 RS-485 Interconnect Cable	109512-00, J9 RS-485
MFC #2 500 sccm SO2	Attached Cable	103284-00, J16
MFC #1 10 LPM SO2 Dil	Attached Cable	1032840-00, J19
Shutdown Valves	Attached Cable	110973-00, J6
Pressure Transducer, ED	Attached Cable	110976-00, J15
Pressure Transducer, DIL	Attached Cable	110976-00, J25
Pressure Regulator, ED	Attached Cable	110789-00, J27
Pressure Regulator, DIL	Attached Cable	110789-00, J35
Vacuum XDCR	Attached Cable	110968-00, J11

Probe Pneumatic, Cable and Wiring Connections

In this section, Figure 6–10 through Figure 6–13 and Table 6–2 through Table 6–4 display the Pneumatic, Cable and Wiring Connections that are on top of the Probe.

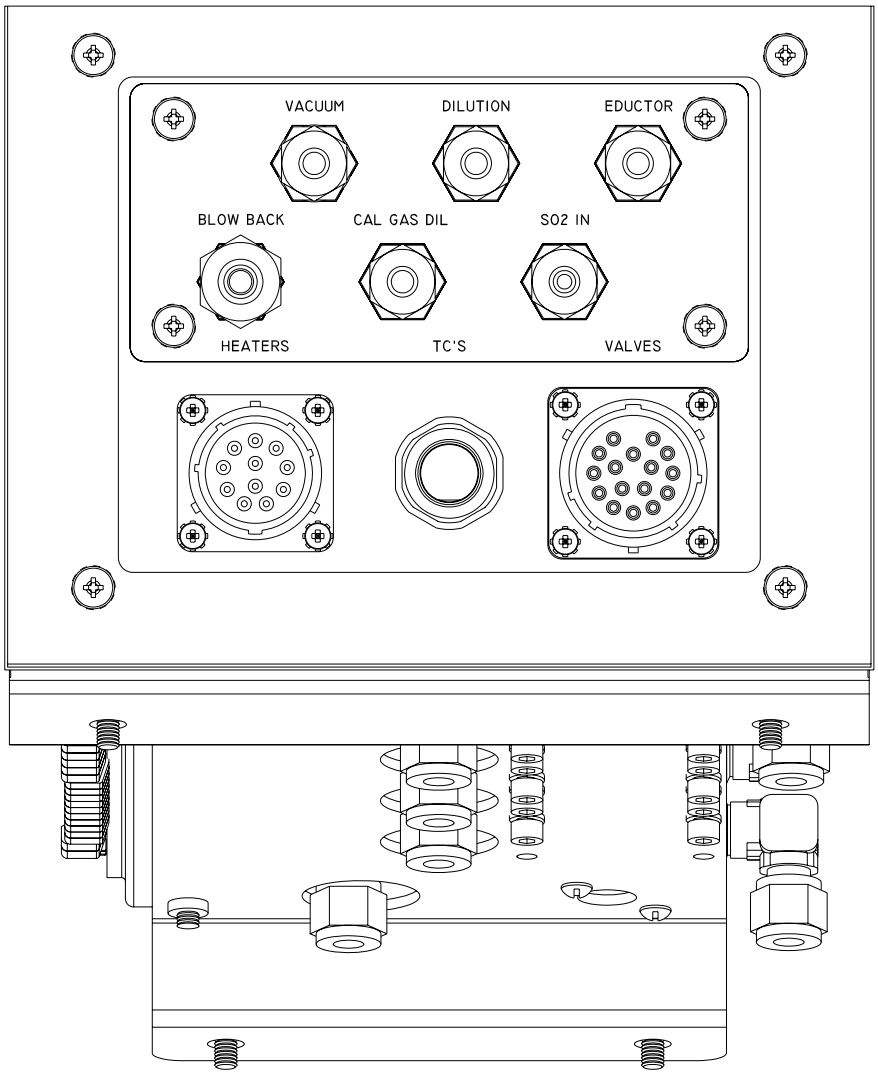


Figure 6–10. Probe bulkheads, heater, and Valve Connections (Front)

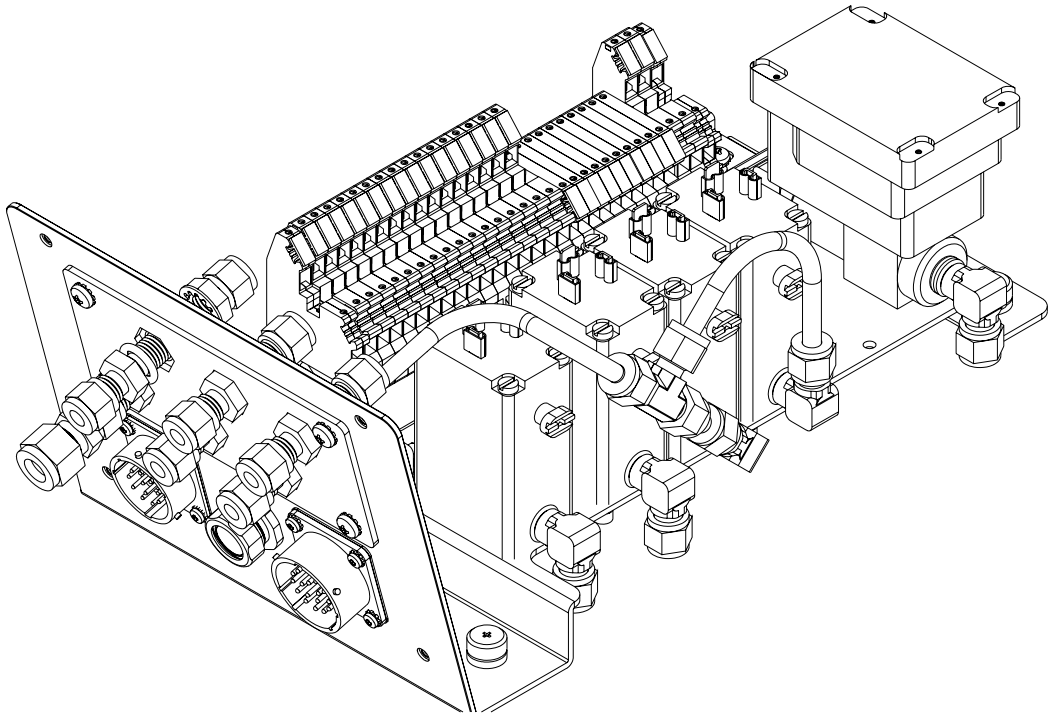


Figure 6–11. Probe Terminations and Pneumatics (Side)

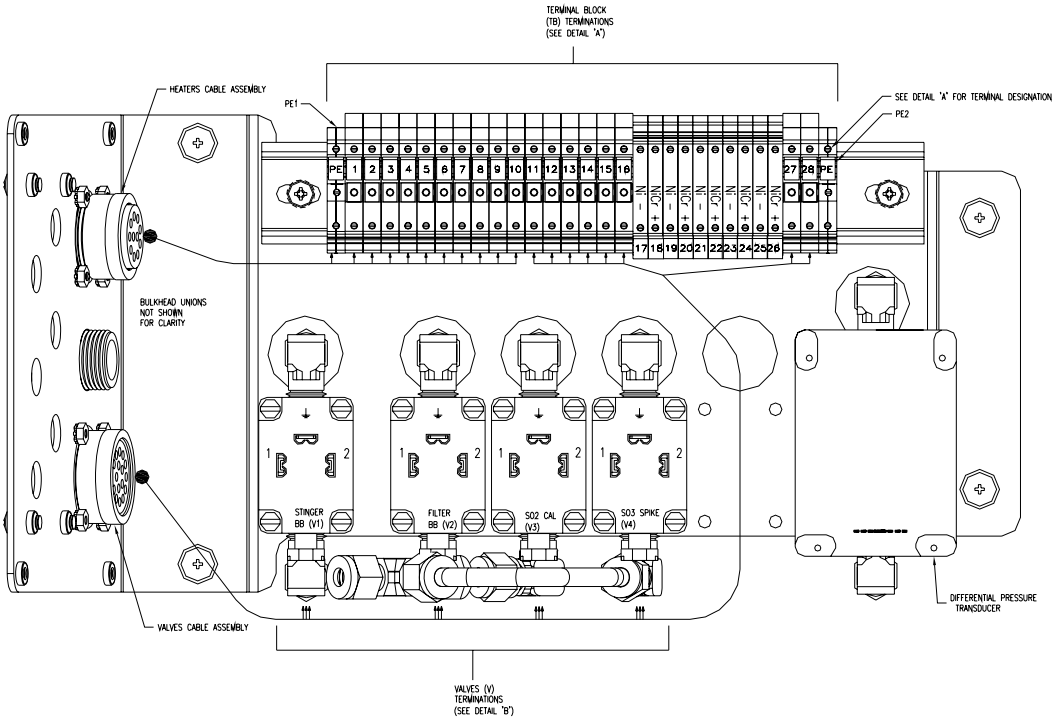


Figure 6–12. Probe Terminations and Pneumatics (Overhead)

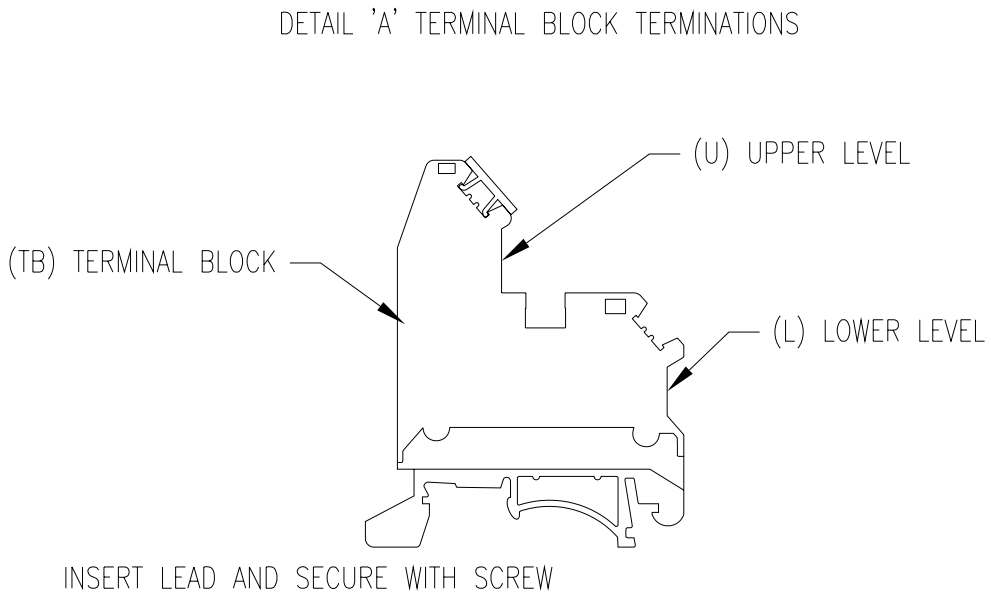


Figure 6–13. Terminal Block

Table 6–2. Heater Cable Assembly Terminations

From	Wire Color	TO TB-	Function
A	Green/Yellow	PE1(L)	Earth Ground
B	Red	1(L)	H1 & H2 (Probe)
C	Red	2(L)	H1 & H2 (Probe)
D	Blk	3(L)	H3 (Orifice)
E	Blk	4(L)	H3 (Orifice)
F	Brn	5(L)	H4 (Generator)
G	Brn	6(L)	H4 (Generator)
H	Blu	7(L)	H5 (Stinger)
J	Blu	8(L)	H5 (Stinger)
K	Vio	9(L)	H6 (Spike)
L	Vio	10(L)	H6 (Spike)

Table 6–3. Valve Cable Assembly Terminations

From	Wire Color	To	Function
A	Yel/18	(All Valves)	Line V
B	Grn/Yel/18	(All Valves)	Common
C	Vio/18	V1-2	V1 Return
D	Blu/18	V2-2	V2 Return
E	Gry/18	V3-2	V3 Return
F	Org/18	V4-2	V4 Return
G	Blk/20	TB-27(L)	DPX (-)
H	Wht/20	TB-28(L)	DPX (+)
J	Red/20	TB-15(L)	Spare (+)
K	Grn/20	TB-16(L)	Spare (-)
L	Not Used	-	-
M	Blk/18	TB-11(L)	Spare
N	Wht/18	TB-12(L)	Spare
P	Red/18	TB-13(L)	Spare
R	Brwn/18	TB-14(L)	Spare
S	Not Used	-	-

Table 6–4. Differential Pressure Transducer Terminations

From	Color	To
COMM	Black	TB-27(U)
EXC	White	TB-28(U)

Cable Assembly Connections (Heaters, Valves, and Optical Bench)

See Table 6–5 lists the cable connections for Heater, Valves, and Optical Bench at the System Control board.

Table 6–5. Cable Assembly Connections (Heaters, Valves, and Optical Bench)

From	Description	To
110965-00, Heaters	2-Pin, Blue	109496-00, J3, Generator Stitch
	2 Pin, Black	109496-00, J4, Orifice Stitch
	2-Pin, Violet	109496-00, J8, Stinger
	2-Pin, Brown	109496-00, J9, Generator
	2-Pin, Red	109496-00, J11, Probe
	Ring Lug	Chassis Ground 1
110966-00, Valves	4-Pin	109930-00, J37, Press Xdcr
	6-Pin	109930-00, J7, Probe Solenoid
	Ring Lug	Chassis Ground 2
Assembly, Heaters, Optical Bench	2-Pin, Brown (from under Bench)	109496-00, J10, Route thru bottom square of bracket
Assembly, TC, Optical Bench	Thermo Couple Plug	109930-00, J28, Bench Thermo Couple
CB1-2	110961-00, Brown Lead	TB1, AC1
CB1-4	110961-00, Blue Lead	TB1, AC2
109930-00, J1 AC IN	110964-00	109946-00, J1

Finding and Optimizing the Correct SO_3 Peak

If, during system span or auto calibration, the SO_3 peak is not visible then the following procedure may be required. This section of the manual instructs the user on how to locate and optimize the correct SO_3 peak.

WARNING Adjusting the detector controls and laser controls by a non-qualified individual can result in damages to the detector and laser. ▲

1. **Gas Mode:** Put the System in System Zero mode.

2. **Alignment:** It is assumed that the laser and detector have already been aligned and that there are at least 3 LEDs lit at the detectors LED strip.
   a. If there are less than 3 LEDs lit, then increase the laser voltage percentage in increments of 1 until you see 3 LEDs lit.
   b. If there are more than 3 LEDs lit, then decrease the laser voltage percentage in increments of 1 until you see 3 LEDs lit.

3. **Horizontal:** Make the blue curve at the Raw spectrum as horizontal as possible by applying the following detector adjustments:
   a. Adjust the detectors vertical angle up and down until you see a horizontal blue curve. Allow 10 seconds for scrren to update.
   b. You will need to adjust the vertical position of the detector as you do part a. above.

4. **Flat:** Make the blue curve at the Raw spectrum as flat as possible by adjusting:
   a. Offset Ref DAC
      i. Decrease value: Raw Spectrum mid-right section goes UP
      ii. Increase value: Raw Spectrum mid-right section goes DOWN
      iii. An increase of 0.1 is a 0.2 °C change in Laser temperature.

WARNING Do not exceed 0.3V. ▲

   b. Ramp Ref DAC
      i. Decrease value: More curved on the left side; Left side goes DOWN

ii. Increase value: Less curved on the left side; Left side goes UP

iii. An increase of 0.1 is a 0.1 °C change in Laser temperature.

WARNING Do not exceed 2.5V. ▲

5. Y-axis

a. Using the Laser Voltage control, adjust the Raw spectrum y-axis maximum to about 0.70 to 1.0.

b. If there is an etalon effect (repeating sine wave), decrease the Laser voltage percentage in increments of 1.

c. If the y-axis maximum gets below 0.5 and the etalon is still present, then increase the laser percentage in increments of 1% (without exceeding 1.2 on the y-axis).

6. Locate Water

a. Put the System in Sample mode.

b. Set the Laser Setpoint temperature to 10 °C.

c. The user will be going back and forth from System Status and Alarms screen & Raw Spectrum screen for this step.

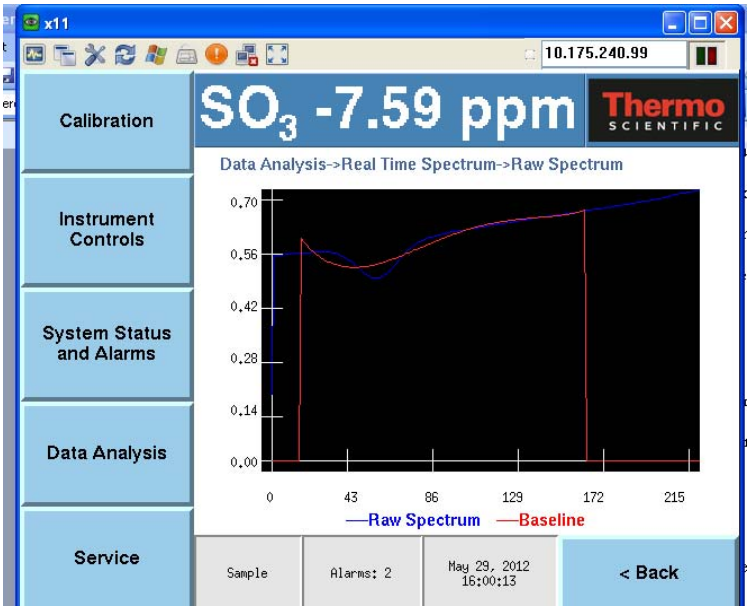
i. Go to the Raw Spectrum and see if you notice a very large broad dip in signal (**blue** curve).

ii. If you do not see the large water peak then increase the laser temperature setpoint by 0.4 °C.

iii. Go back to the Raw spectrum and see if the water peak is present.

iv. If not, then continue to repeat steps i–iii until you reach 16 °C. The water peak should be seen between 10–16 °C. If not, then troubleshooting may be required. For instance, be sure to check Bench Vacuum.

d. See Raw Spectrum below. The water peak (blue curve) should look something like this:



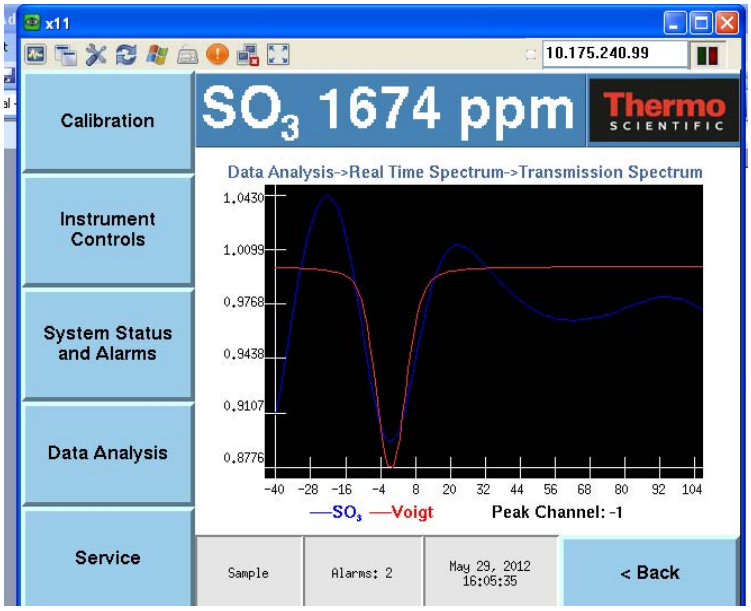
e. Next fine tune the water peak at the Transmission Sceen. Position the water peak around channel 0 (x-axis).

   i. If the peak is to the left of channel 0, then increase the temperature of the laser slightly (try going in small 0.05 °C increments).

   ii. If the peak is to the right of channel 0, then decrease the temperature of the laser slightly.

f. When you locate and position the Water peak, record laser temperature.

g. See Transmission Spectrum below. The water peak (blue curve) should look something like this:

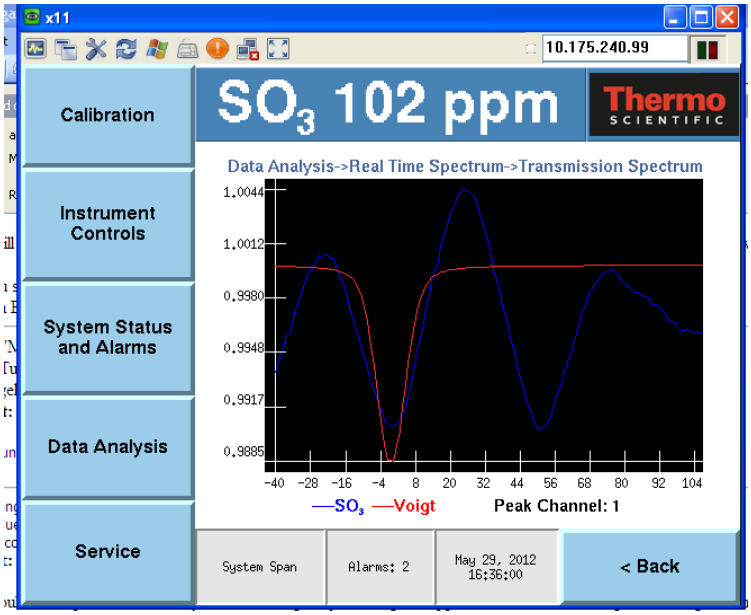


7. **Locate SO_3**

   a. Change the gas mode to System Span and allow 30 minutes.

   b. Add 3 °C to the laser temperature.

   c. Go to the Transmission Spectrum. Does it look like this:



   d. If it does not, increase the laser temperature by 0.4 °C until you see 2 large SO_3 peaks as shown above.

   e. Position the left peak at channel 0.

i. If the peak is to the left of channel 0, then increase the temperature of the laser slightly (try going in small 0.05 °C increments).

ii. If the peak is to the right of channel 0, then decrease the temperature of the laser slightly.

f. When this has been accomplished, the correct SO_3 peak has been found.

8. Optimize the Zero noise and Set Zero Background

a. Put the system in Zero mode. Wait for 30 minutes.

b. Record initial laser voltage percentage.

c. What is the minimum y-axis value? It should be about 0.9990 (±0.002).

i. If it is above 0.9992 then decrease the laser voltage percentage by increments of 1 until the y-axis minimum is 0.9990.

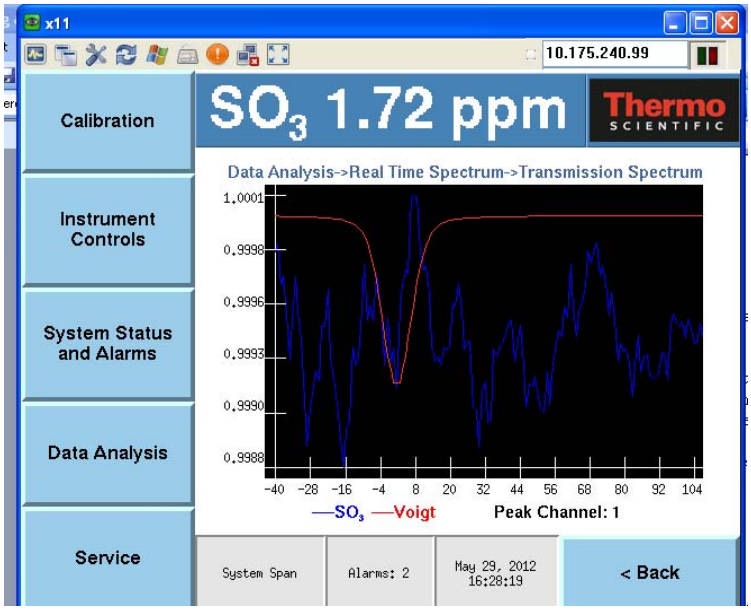
ii. If it is below 0.9988 then increase the laser voltage percentage by increments of 1 until the y-axis minimum is 0.9990.

d. Record new laser voltage percentage.

i. Subtract: new laser voltage percentage – initial laser voltage percentage. Then multiply that number by 0.02. (The resulting number may be positive or negative.)

ii. Add this value to the laser temperature and save new setpoint.

e. Here is what the zero noise should look like:



9. Set SO_3 span coefficient

a. Go to the Calibration Settings screen. Enter these settings:

i. Span Setting: 100 ppm

ii. Cylinder Concentration: set to actual SO_2 cylinder concentration

iii. SO_2 Flow Setpoint: 0.30 L/min

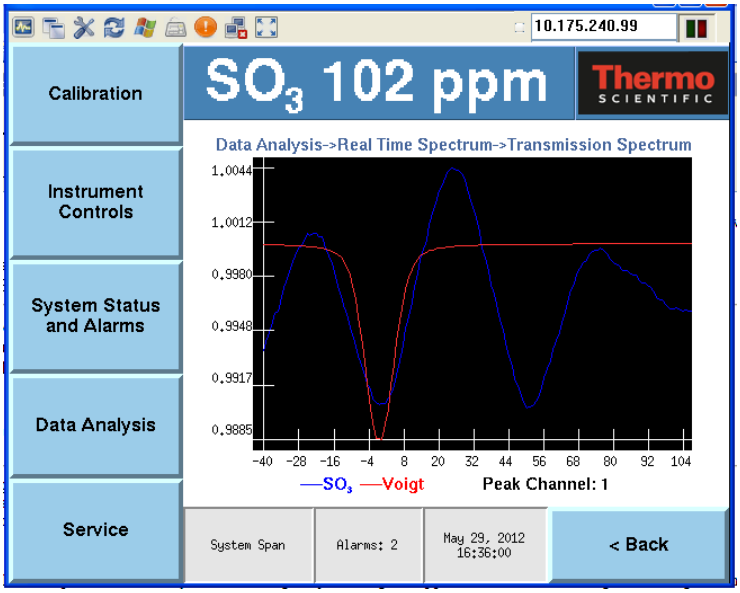
b. Put the system in Span mode. Wait for 30 minutes.

c. Go to the Transmission Spectrum screen and fine tune the left SO_3 peak so that it is at (or near) channel 0.

d. Make the SO_3 reading as close to 100 ppm as you can by increasing or decreasing the System Coefficient

e. Go to Manual calibration and press on Set Span.

f. The SO_3 Transmission Spectrum should look like this:



Service Locations

For additional assistance, Thermo Fisher Scientific has service available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www. thermoscientific.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 7
System Component Description

The System Component Description chapter provides an overview of the components in the 9800 SO_3 Analyzer and PRO9805 Dilution Extractive Probe, describes the function of the system components, and provides a typical system plumbing hookup per the following:

The 9800 SO_3 Analyzer components include:

- "Computer Assembly" on page 7-3
- "Pneumatic Assembly" on page 7-4
- "AC Mains" on page 7-5
- "HVAC" on page 7-6
- "Optical Assembly" on page 7-6
- "System Electronics Assembly" on page 7-7
- "Pneumatic and Tubing Connections" on page 7-8

The PRO9805 Dilution Extractive Probe components include:

- "Fast Loop Assembly" on page 7-10
- "Orifice Block" on page 7-10
- "Dilution Module" on page 7-10
- "Venturi Tube Assembly" on page 7-10
- "Critical Orifice" on page 7-11
- "Pre-Filter" on page 7-11
- "Differential Pressure Transducer" on page 7-11
- "Inertial Filter" on page 7-11
- "Accumulator Tank" on page 7-11
- "Valves" on page 7-11
- "Critical Orifice Post Dilution Module" on page 7-11

- "Stinger/Heater Assembly" on page 7-11
- "SO3 Generator Component Description" on page 7-12

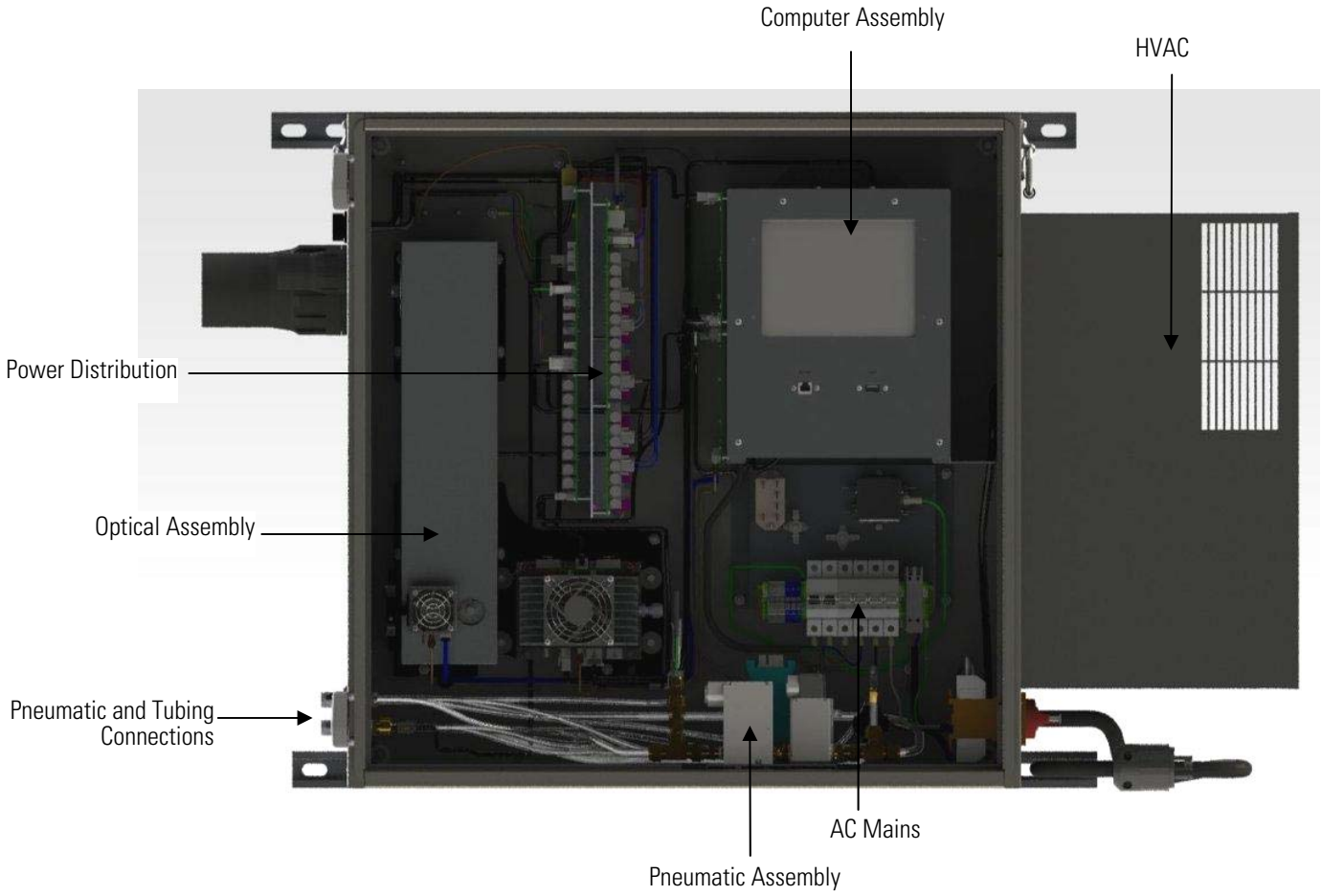


Figure 7–1. SO_3 Analyzer

Analyzer

The following describes the analyzer components.

Computer Assembly

The computer Assembly contains the user interface, computer boards, and computer peripherals.

Touch Screen

Allows the user to easily control and navigate the Instruments graphical user interface.

Network Connector

The network connecter is a Cat-5 8 position modular jack. It allows the user to remotely connect to and control the Instrument and also download data logged information.

USB Port

The USB 2.0 Port allows the user to download data logged information directly from the Instrument using a USB thumb drive.

Motherboard

The Motherboard connects the central processing unit (CPU) to other systems and devices. It allows other components and peripherals of the system to be electrically connected.

ATX Power Supply

The ATX Power Supply converts AC electrical energy to DC. It supplies electricity to the system.

Hard drive

The Solid State High Density Drive stores and retrieves digital information. The hard drive will store data logged information which can be retrieved using a thumb drive (at the Instrument) or remotely by using a program such as ePort.

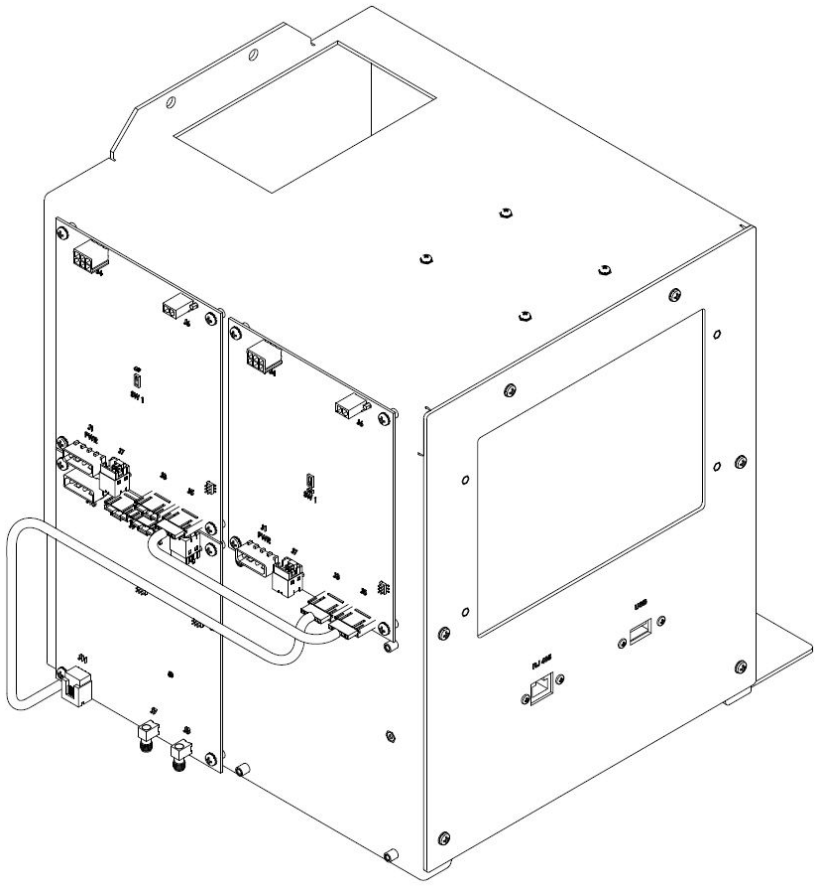


Figure 7–2. Pneumatic Assembly

Pneumatic Assembly

The Pnematic Assembly includes devices to regulate and control air and span gas going to the probe.

Mass Flow Controllers

The 2 mass flow controllers regulate the SO_2 span gas and Span Dilution Air flows during calibration.

Fixed Regulator for Span Dilution Air MFC

Maintains precise air pressure feed to the Span Dilution Air MFC.

Eductor Pressure Regulator, Valve and Sensor Assembly

Regulates the eductor flow which pulls sample gas through the fastloop of the probe.

Dilution Pressure Regulator, Valve and Sensor Assembly

Regulates the system dilution flow to the dilution module.

AC Mains

The AC Mains includes switches to turn on/off instrument and probe devices and boards.

Circuit Breakers

The 3 circuit breakers are electrical switches used to turn on/off different parts of the system. The left circuit breaker controls the heaters used by the Instrument and Probe. The center circuit breaker provides power to the Power Supply. The right circuit breaker provides power to the Air Conditioner.

Thermal Runaway Switches and Relay

In cases where there is a runaway in temperature inside the Chassis, there are 2 thermal runaway snap switches which will power down the Instrument in order to avert thermal damage. If activated, the user can reset them by pressing the button. They are located on the AC Mains assembly. The snap switch labeled 120 will turn off all heaters if the the chassis temperature reaches 120 °F. The snap switch labeled 140 will turn off the HVAC if the chassis temperature reaches 140 °F.

Line Filter

Electronic filter that attenuates radio frequency interference (RFI).

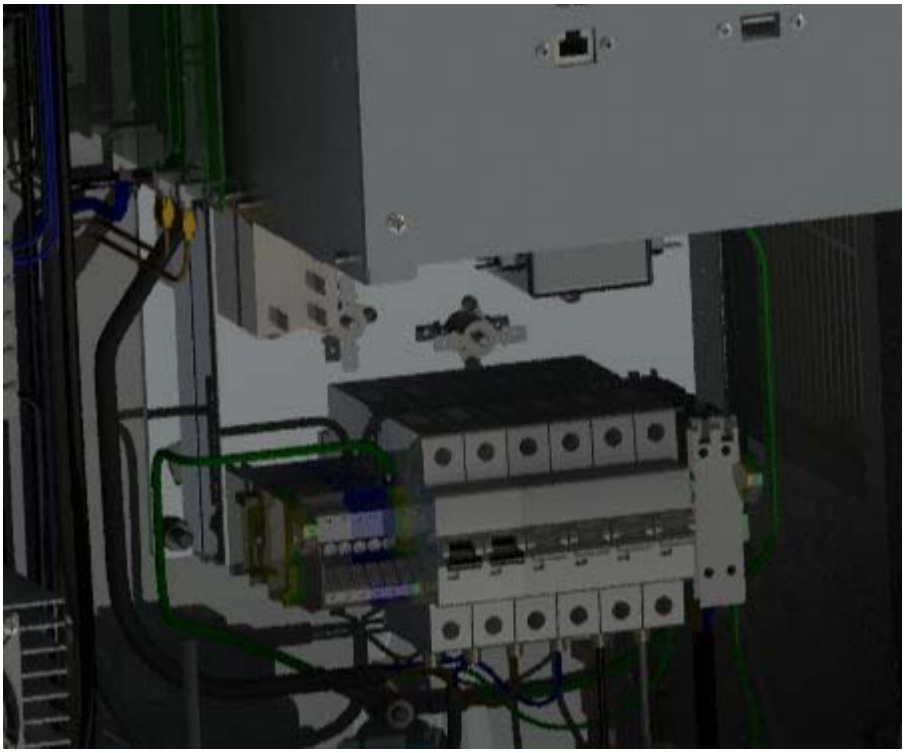


Figure 7–3. AC Mains

HVAC

Air conditioning unit to maintain chassis temperature.

Instrument chassis temperature is maintianed by the HVAC unit mounted on the right side of the chassis.

Optical Assembly

The Optical Assembly includes the light source (laser), pathway (cell), and laser light detection (detector).

Heated White Cell

The heated white cell optical bench is where the SO_3 is measured. Laser light is bounced inside the bench until it reaches the detector assembly. The cell has an effective pathlength of 12 meters. Part of the bandwidth is absorbed by SO_3 inside the cell. This attenuation of signal is detected at the detector as the SO_3 peak.

Detector Assembly

Detects the laser light after it has passed through the optical bench. SO_3 molecules will absorb part of the spectrum creating a feature (peak) in the spectrum, which is detected at the detector. This spectrum is then measured by the Process Control Program algorithm, which calculates the SO_3 concentration.

Laser assembly

The Laser Assembly contains a thermal electrically cooled quantum cascade laser. A specific wavelength of light is generated whereby a portion of it is absorbed by SO_3 molecules. This light (or lack of light) passes through the optical bench and is detected by the detector.

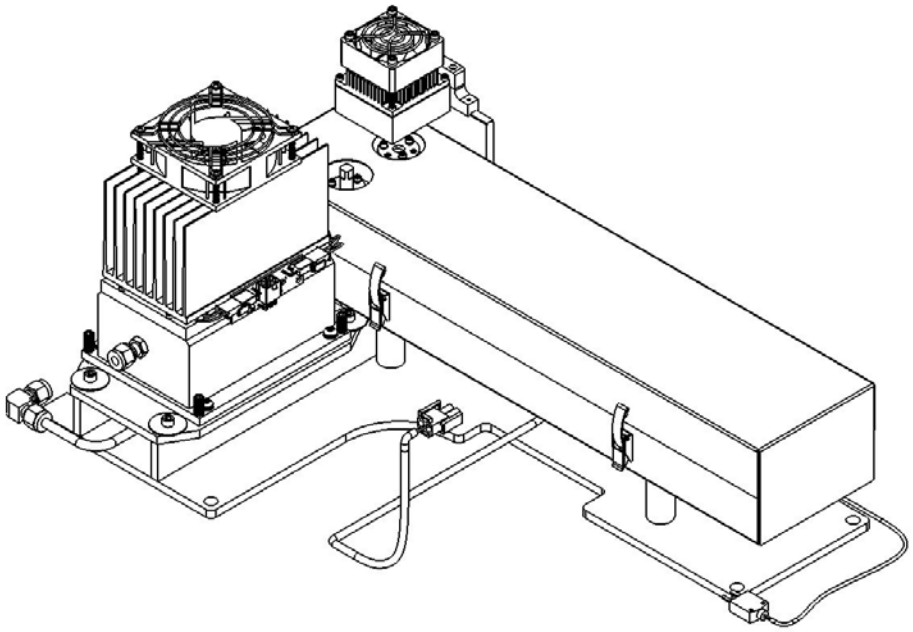


Figure 7–4. Line Filter

System Electronics Assembly

The System Electronics Assembly consists of two boards attached to the center panel in the Instrument Chassis and provides power to Instrument and Probe components.

Power Distribution Board

The Power Distribution Board, located on the right side of the center panel in the Instrument Chassis, contains relays and fuses for heater control.

System Control Board

System Control Board, located on the left side of the center panel located in the Instrument Chassis, supplies power to components such as valves and regulators. It also connects the thermocouples inputs for heater control. It also contains eight fuses; six for the gas mode solenoids and two spares.

Figure 7–5. System Electronics Assembly

Pneumatic and Tubing Connections

The Pneumatic and Tubing Connections includes all lines going from the Instrument to the Probe.

Teflon Tubing

On the left side of the outside of the Instrument Chassis there are bulkhead connector fittings for all tubing going to and from the Instrument and Probe.

Heater Cables

Heater cable connections that go from the Instrument Chassis to the Probe.

Valve Cables

Valve cable connections that go from the Instrument Chassis to the Probe.

Figure 7–6. PFA Tubing Connections

Probe

The following describes the analyzer components.

The probe weighs approximately ninety-five pounds and consists of a 2-inch mounting flange, 2 side access panels, an isolated electrical compartment, and the main compartment.

The electrical compartment houses a filter blow back valve, stinger blow back valve, Cal/zero valve, a venturi tube differential pressure transducer, and a Phoenix™ DIN-rail block for all electrical connections.

The main compartment consists of a “fast loop” assembly, an SO_3 generator, and a 3-inch strain relief for the umbilical cord.

The fast loop assembly consists of an inertial filter, particulate filter, critical orifice, main eductor assembly, dilution eductor assembly, venturi tube assembly, and a pressure tap, all of which are entombed in a heated aluminum block.

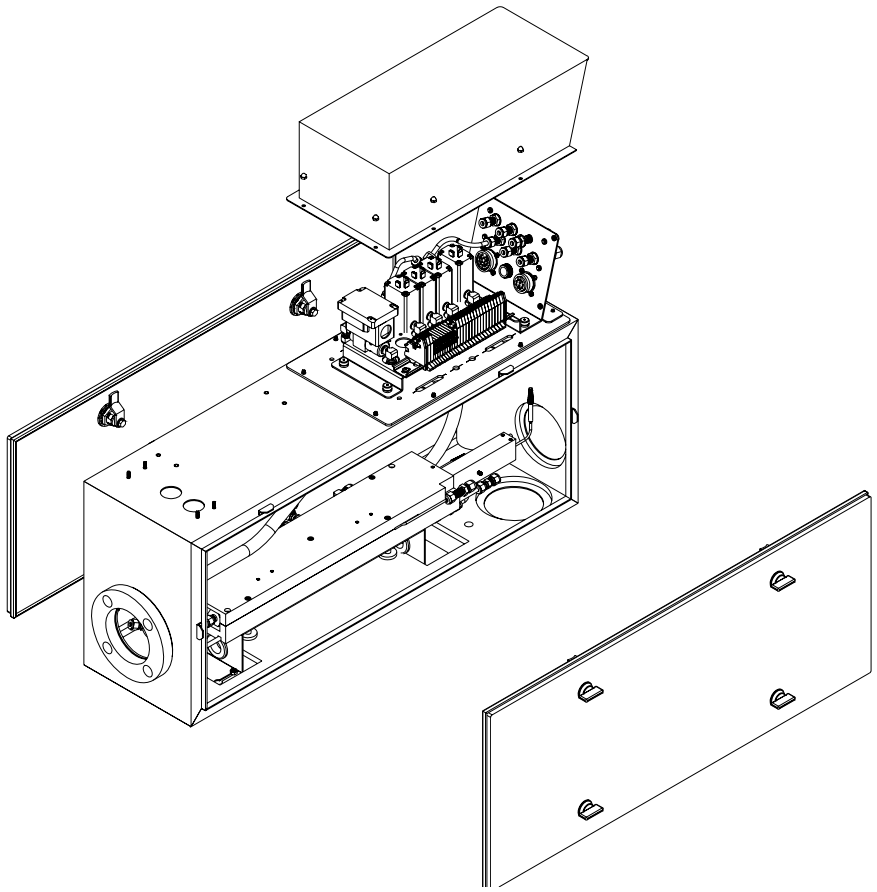


Figure 7–1. PRO9805 Dilution Extractive Probe System Description

Fast Loop Assembly

The fast loop assembly draws sample flow from the process and returns it back to the stack. The sample is pulled in by means of an eductor.

Orifice Block

The orifice block, which is heated, contains an orifice and filter which connects the diluted sample to the heated sample line. It keeps the components at or near 300 °C.

Dilution Module

The dilution module dilutes the sample with zero air and delivers it to the analyzer via the heated umbilical cord. The outlet of the dilution module requires an atmospheric dump. This dump should be plumbed to vent.

Venturi Tube Assembly

The venturi tube assembly provides a pressure differential that is measured by a pressure transducer to determine fast loop flow rate.

Critical Orifice

The critical orifice provides a constant flow pulled by the dilution module.

Pre-Filter

The pre-filter limits particulate from getting into the sample system.

Differential Pressure Transducer

This transducer measures the differential pressure across the venturi. This differential pressure is used to determine fast loop flow.

Inertial Filter

The inertial filter is a filter assembly with a porous filter element that can be cleaned in situ by simple blow back. This filter element is a coated 316L stainless steel 10-inch long diffusion-bonded, sintered seamless porous tube with a 0.5 micron grade.

A filter housing tube surrounds the tubular element, creating a minimum-volume annular plenum for sample collection. A high-efficiency gas eductor induces axial flow through the filter element.

Accumulator Tank

The accumulator tank allows the blow back valves to blast the two sections of the sample inlet system with a volumetric force of air.

Valves

There are four valves at the probe: SO_3, SO_2, filter blow back, and stinger blow back.

Critical Orifice Post Dilution Module

This maintains pressure and flow of the diluted sample between the exit of the dilution module and the heated sample line.

Stinger/Heater Assembly

The stinger heater is mounted around the portion of the stinger that is located in the mantle assembly. The mantle assembly is mounted to the probe box and passes through the stack outer wall to the inner wall. The stinger extends to at least three feet into the inner stack.

SO_3 Generator Component Description

The SO_3 Generator components (refer to Figure 7–2) include:

- SO_3 Generator U-tube
- Heater
- Heater Block
- Thermocouple
- Insulation
- Generator Enclosure
- Enclosure Bracket

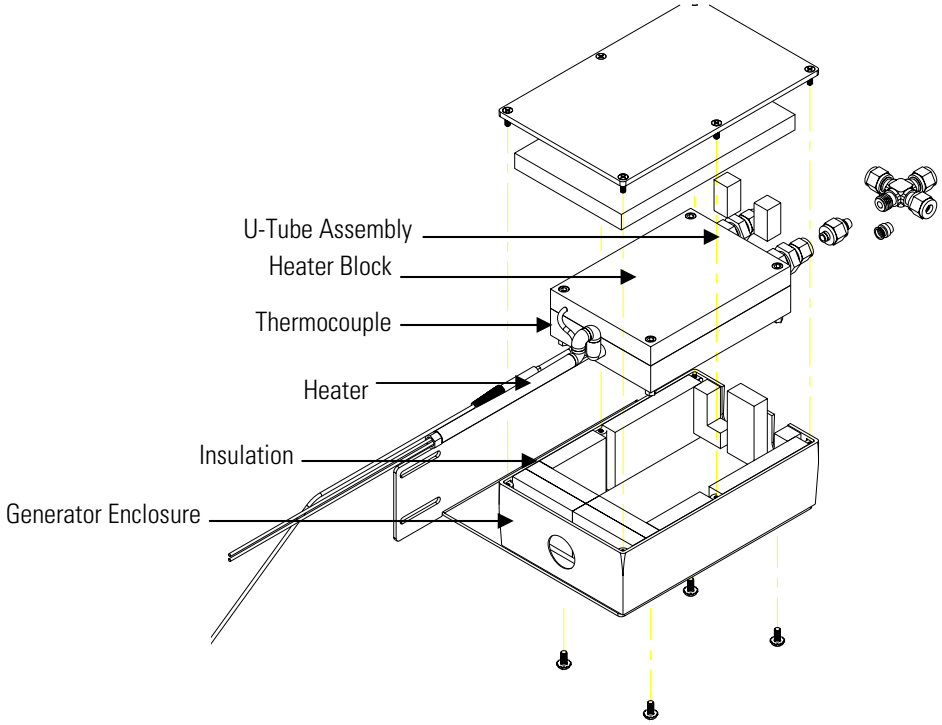


Figure 7–2. SO_3 Generator Components

SO_3 Generator U-Tube

The Generator u-tube acts as a reaction chamber that generates SO_3 gas when SO_2 and Air are reacted together.

Heater

The heater is a 240 V, 450 W firerod-style heater that heats the heater block and generator weldment to approximately 425 °C to facilitate the oxidation reaction.

Heater Block The heater block encloses the SO_3 Generator U-tube ensuring even heating.

Thermocouple Type K thermocouple used to measure the Generator temperature.

Insulation The insulation surrounding the heater block helps maintain a uniform and constant temperature.

Generator Enclosure The SO_3 Generator enclosure is an aluminum box that contains the oxidizer components.

Enclosure Bracket The SO_3 Generator Enclosure is screwed into the Enclosure Bracket. The Enclosure Bracket is secured to the probe case.

Appendix A
Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which

they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.

Appendix B
ePort PC Software

For users that wish to utilize the SO_3 instrument's Ethernet port to download instrument data, users must first install the ePort software on a personal computer (PC) connected to the same network as the SO_3 instrument that data will be downloaded from. At the same time the ePort software is installed, the installer will install Microsoft .NET Framework software if the PC does not already have an up-to-date version of .NET Framework.

See the following topics:

- "Installing ePort" on page B-1
- "Connecting to the SO3 Instrument" on page B-6
- "Finding Instruments on a Network" on page B-9
- "Setting Up for Manual Data Downloads" on page B-11
- "Setting Up for Automatic Data Downloads" on page B-12
- "Performing a Data Download" on page B-14
- "Downloading Data to a Flash Drive" on page B-15
- "Viewing Downloaded Data" on page B-17

Installing ePort

Use the following procedure to install the ePort software:

1. Locate and double-click on the "setup ePort _XX.exe" file (where "XX" is the version number) on the software CD that came with the SO_3 instrument. The "Welcome to InstallShield Wizard" screen will display (Figure B–1).

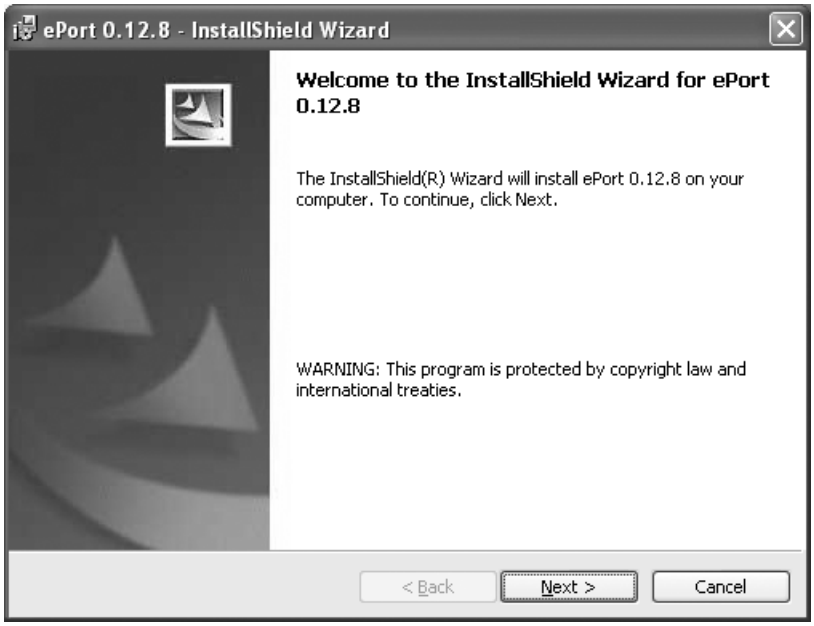

ePort 0.12.8 - InstallShield Wizard
Welcome to the InstallShield Wizard for ePort 0.12.8
The InstallShield(R) Wizard will install ePort 0.12.8 on your computer. To continue, click Next.
WARNING: This program is protected by copyright law and international treaties.
< Back
Next >
Cancel

Figure B–1. ePort Welcome to InstallShield Wizard Screen

2. Select the “Install” button.

3. The wizard will display the software license agreement. Select “Yes,” then select the **Next >** button.

4. The Windows update screen will display (Figure B–2). If you have recently updated your Windows XP software, select the **Next >** button.

Note The ePort software MUST be installed on a PC with the latest Windows XP updates. If you have not updated your Windows XP system, select the “Cancel” button and use the Windows Update function of the PC to update the operating system before attempting to install the ePort software. ▲

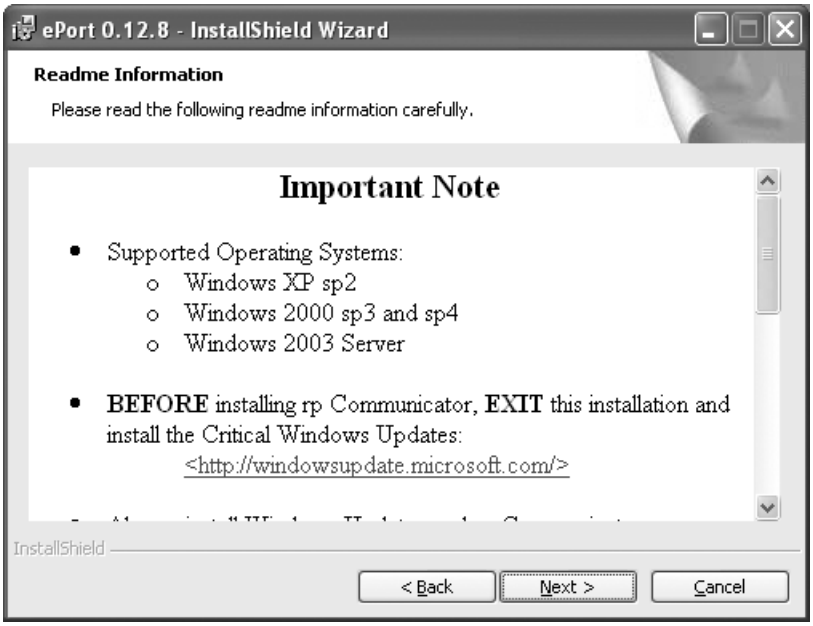


Figure B–2. Windows Update Notice

5. The Customer Information screen will display. Type in the information and select the **Next >** button.

6. The Ready to Install Program screen will display (Figure B–3). Select the **Install** button.

Figure B–3. Ready to Install the Program Screen

7. The wizard will post messages showing the progress of the installation. When the process is complete, the Finish screen will display (Figure B–4). Select the **Finish** button.

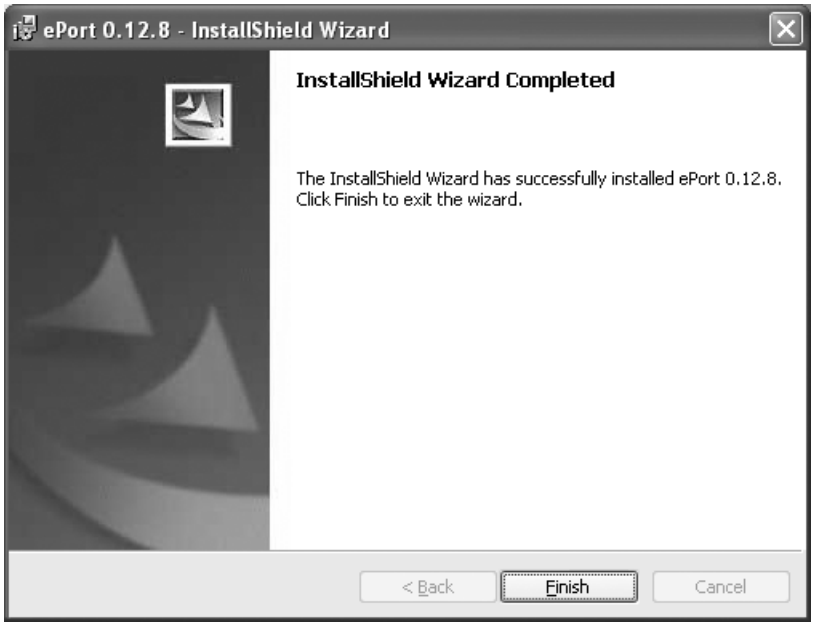

ePort 0.12.8 - InstallShield Wizard
InstallShield Wizard Completed
The InstallShield Wizard has successfully installed ePort 0.12.8. Click Finish to exit the wizard.
< Back
Finish
Cancel

Figure B–4. InstallShield Wizard Completed Screen

8. If the PC does not have an up-to-date version of Microsoft .NET Framework software, the system will automatically begin installing that software. The Microsoft .NET Framework Welcome screen will display (Figure B–5). Select the **Next >** button.

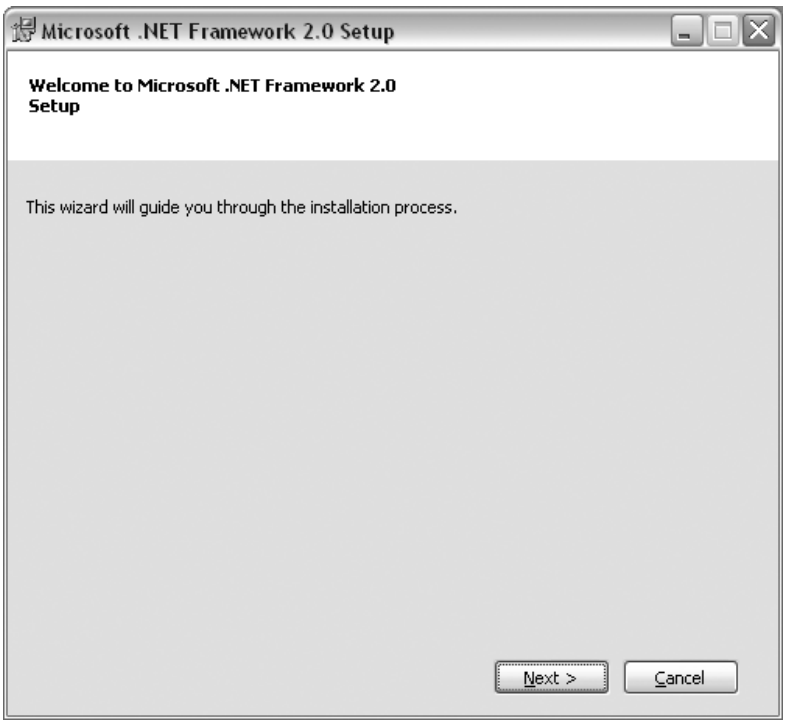

Microsoft .NET Framework 2.0 Setup
Welcome to Microsoft .NET Framework 2.0 Setup
This wizard will guide you through the installation process.
Next >
Cancel

Figure B–5. Microsoft .NET Framework Welcome Screen

9. Select **Install**. The system will begin installing the Microsoft .NET Framework software. The wizard will post progress messages during the installation.

Note If the Microsoft .NET Framework software is already installed on the PC, the wizard will ask you to Repair or Remove the software. Select **Repair** to ensure the latest version is installed on the PC, or select **Cancel** to skip the Microsoft .NEW Framework installation. ▲

10. When the installation is complete, the Setup Complete screen will display (Figure B–6). Select the **Finish** button to complete the ePort and Microsoft .NET Framework installation.

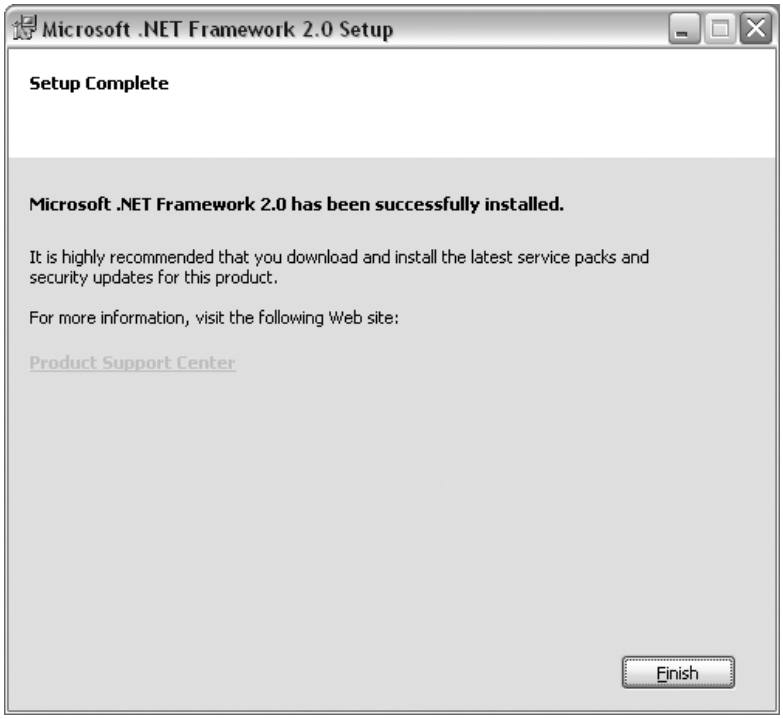

Microsoft .NET Framework 2.0 Setup
Setup Complete
Microsoft .NET Framework 2.0 has been successfully installed.
It is highly recommended that you download and install the latest service packs and security updates for this product.
For more information, visit the following Web site:
Product Support Center
Finish

Figure B–6. Microsoft..NET Framework Setup Complete Screen

Connecting to the SO_3 Instrument

When the ePort software is installed, and the SO_3 instrument and the PC are connected to the same network, the software can connect to the instrument and download data.

Use the following procedure to connect to the instrument:

1. Ensure that the PC and the instrument are connected to the same network using the Ethernet connection on the back of the instrument. (Refer to the previous section for information on connecting the instrument to a network.)

2. In the System Status screen of the machine from which you want to download data, locate and record the IP address (Figure B–7) of that unit.

Note Instead of looking up the address on the TCP/IP Settings screen, users can also scan for instruments when the instruments are on the same LAN. Refer to "Finding Instruments on a Network" on page B-9. ▲

- From Main menu, press Instrument Controls > Communication Settings > **TCP/IP Settings.**

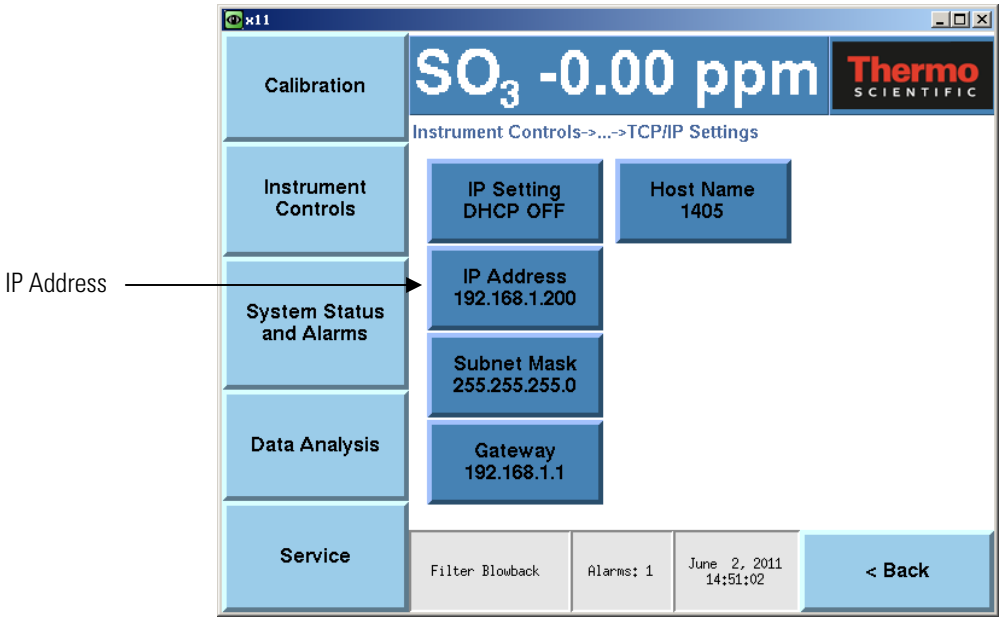


Figure B–7. System Status Screen

3. Start the ePort PC software, using the icon on the PC desktop or the Start menu of the PC. The ePort Main screen with the Open screen will display (Figure B–8).

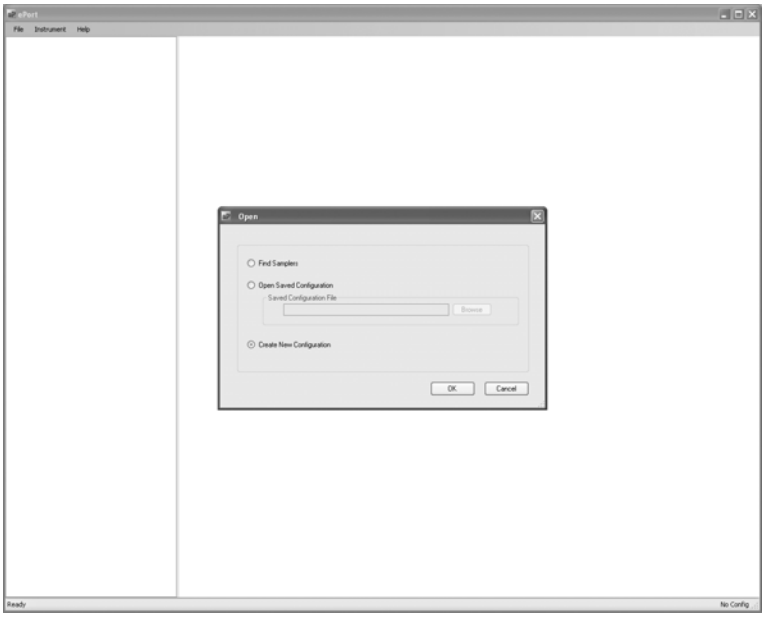


Figure B–8. ePort Main Screen with Open Screen

4. In the ePort Open screen (Figure B–8), select create new configuration. A blank ePort Main screen will display.

5. Select **Instrument** then **New Instrument** from the menu bar at the top of the ePort Main screen (Figure B–9).

Figure B–9. Selecting new Instrument from the Menu Bar

6. The Add New Instrument screen will display (Figure B–10). Enter the IP address, the name assigned to the instrument and the group (if any) assigned to the instrument and select the **OK** button.

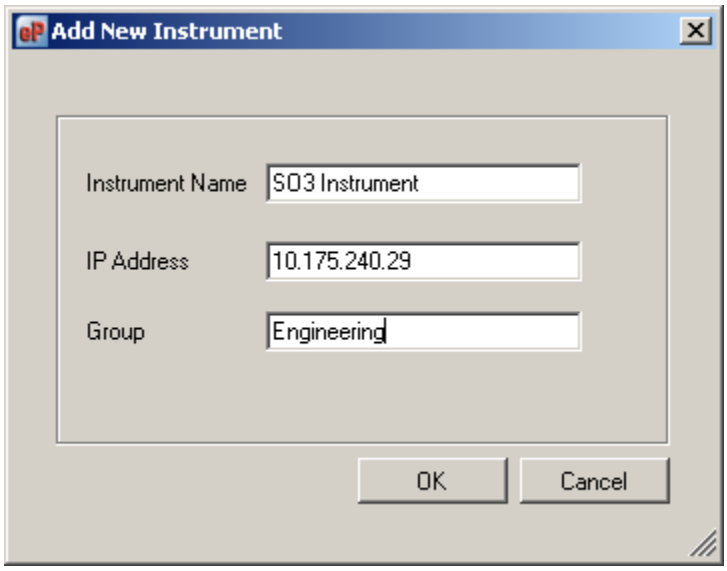


Figure B–10. Add New Instrument Screen

7. The ePort Main screen will display with the selected instrument displayed in the top window (Figure B–11). Repeat the process to add additional instruments to the list.

8. To save this as a configuration, select **File** then **Save** from the menu bar at the top of the Main screen. The Save As screen will display. Type in the desired name for the configuration and select **Save**.

Note Once you have connected to an instrument (or instruments) and saved a configuration file, select **Open Saved Configuration** in the ePort Open screen to open that configuration and automatically connect to all the instruments that were saved in that configuration. ▲

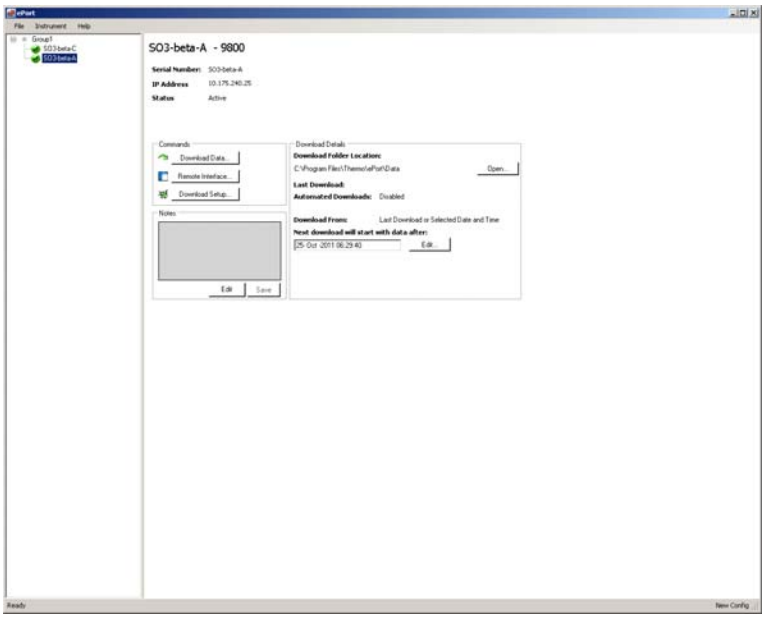


Figure B–11. ePort Main Screen with Instrument Information Displayed

Finding Instruments on a Network

You may use the ePort software to search for all instruments connected to the local network.

Note This function will only locate instruments on a local network. To connect to instruments on other connected networks, you must know the IP address of the instruments and the gateway address (if necessary), and connect to the unit manually using the **New Instrument** function of the software (Figure B–9). Refer to the previous section for information on connecting to an instrument off the local network. Instruments on a network must have a unique IP address, or be connected through a router. ▲

Use the following procedure to locate all instruments on the network:

1. Open the ePort software program and select “Find Samplers” in the Open screen (Figure B–8).

2. The ePort Main screen will display with a “Searching for Instruments...” message. As instruments are located by the software

they will be added to the list in the Instrument frame on the left side of the screen (Figure B–12).

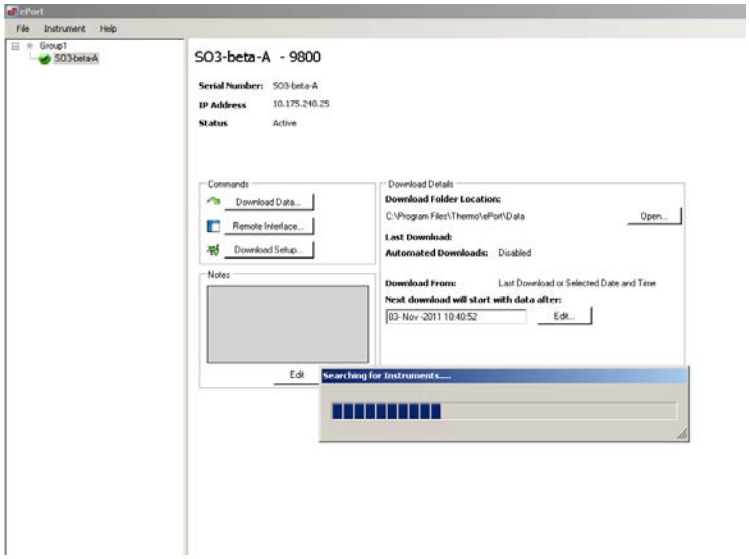


Figure B–12. ePort Main Screen with "Searching for Instrument" Message

3. All instruments located on the local network will be displayed in the Instrument frame on the left side of the Main screen. To edit a displayed instrument or delete an instrument from the list, right-click on the instrument and select Edit Instrument or Delete Instrument (Figure B–13).

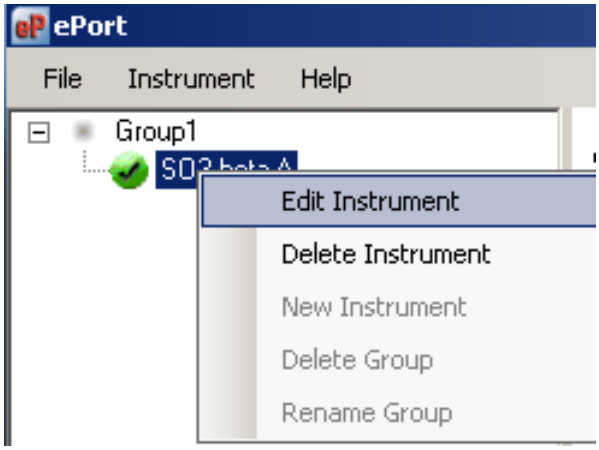


Figure B–13. Adding or Deleting an Instrument from the List

Note To add an instrument from another network connected to the local network select Instrument then New Instrument from the menu bar. Refer to the previous section for more information on manually adding an instrument to the configuration. ▲

4. To save this list as a configuration, select File then Save from the menu bar at the top of the Main screen. The Save As screen will display. Type in the desired name for the configuration and select Save.

Note Once you have connected to an instrument (or instruments) and saved a configuration file, select Open Saved Configuration in the ePort Open screen to open that configuration and automatically connect to all the instruments that were saved in that configuration. ▲

Setting Up for Manual Data Downloads

Data can be remotely downloaded manually from the SO_3 instrument through the built-in Ethernet connection using the ePort software.

Use the following procedure to set up the software to manually download data:

1. Ensure that the PC and the instrument are connected to the same network using the Ethernet connection on the front of the instrument. (Refer to the previous section for information on connecting the instrument to a network.)

2. Use the ePort PC software to connect to the instrument and display the ePort Main screen (Figure B–14). (Refer to the previous two sections for information on connecting to the instrument or instruments.)

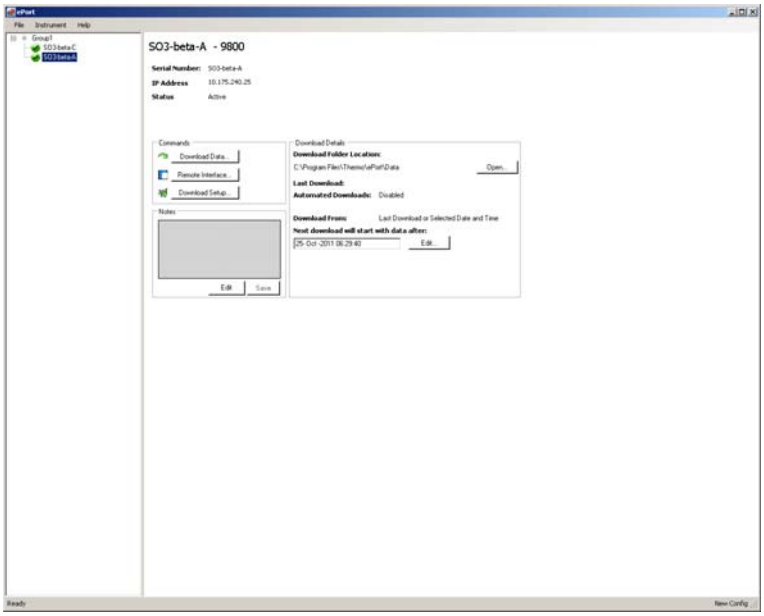


Figure B–14. ePort Main Screen

3. Select **Download Setup** in the Commands window of the ePort Main screen. The Download Setup Wizard will display (Figure B–15). Select the **Next >** button.

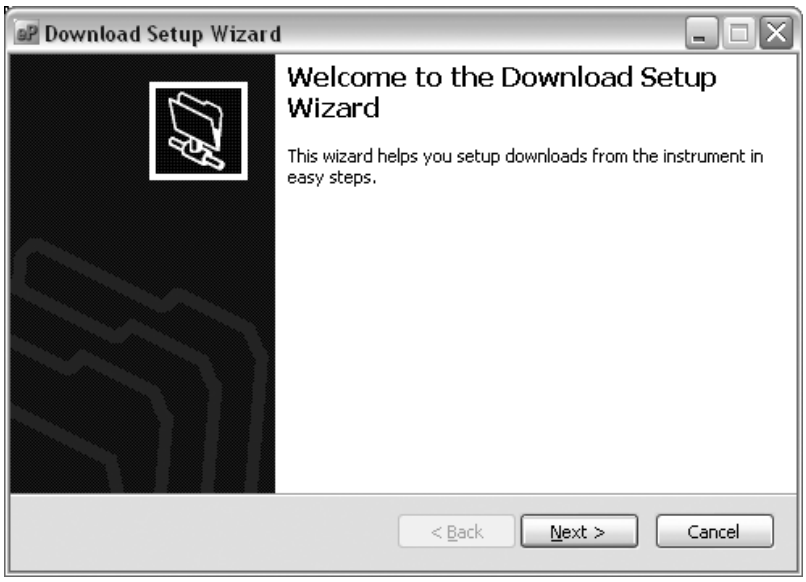

Download Setup Wizard
Welcome to the Download Setup Wizard
This wizard helps you setup downloads from the instrument in easy steps.
< Back
Next >
Cancel

Figure B–15. Download Setup Wizard

4. The Select Data screen will display. Select the data to download (either all data on the instrument or the data since the last download). Select the **Next >** button.

5. The Select Location screen will display. Use the Browse button to select a location for the data file downloaded by the software. Select the **Next >** button.

6. The Download Type screen will display. Select manual downloads. Select the **Next >** button.

7. The Completing the Download Setup Wizard screen will display. Select the **Finish** button.

Setting Up for Automatic Data Downloads

Users can set up automatic downloads for the SO_3 instrument monitor using the ePort software.

Use the following procedure to set up the software to automatically download data:

1. Ensure that the PC and the instrument are connected to the same network using the Ethernet connection on the back of the instrument.

(Refer to the previous section for information on connecting the instrument to a network.)

2. Use the ePort PC software to connect to the instrument and display the ePort Main screen (Figure B–15). (Refer to the previous sections for information on connecting to the instrument or instruments.)

3. Select **Download Setup** in the Commands window of the ePort Main screen. The Download Setup Wizard will display (Figure B–16). Select the **Next >** button.

4. The Select Data screen will display. Select the data to download (either all data on the instrument or the data since the last download). Select the **Next >** button.

5. The Select Location screen will display. Use the Browse button to select a location for the data file downloaded by the software. Select the **Next >** button.

6. The Download Type screen will display. Select automatic downloads. Select the **Next >** button.

7. The Download Schedule screen will display (Figure 3-27). Select a starting date and time, and a download frequency (daily, weekly, hourly). Select the Next > button.

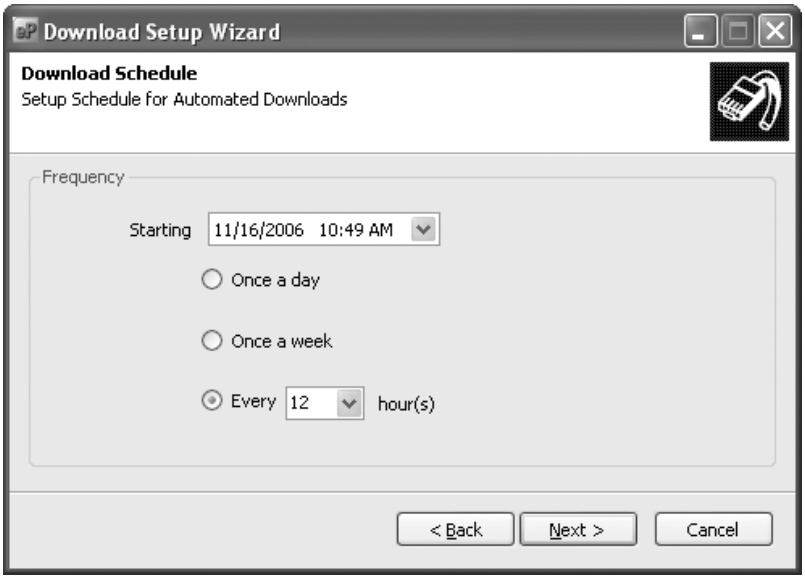


Figure B–16. Download Setup Wizard

8. The Completing the Download Setup Wizard screen will display. Select the **Finish** button.

Performing a Data Download

Use the following procedure to download data:

1. Ensure that the PC and the instrument are connected to the same network using the Ethernet connection on the back of the instrument. (Refer to the Connecting to the SO_3 instrument section for information on connecting the instrument to a network.)

2. Use the ePort PC software to connect to the instrument and display the ePort Main screen (Figure B–14). (Refer to the Connecting to the SO_3 instrument section for information on connecting to the instrument.)

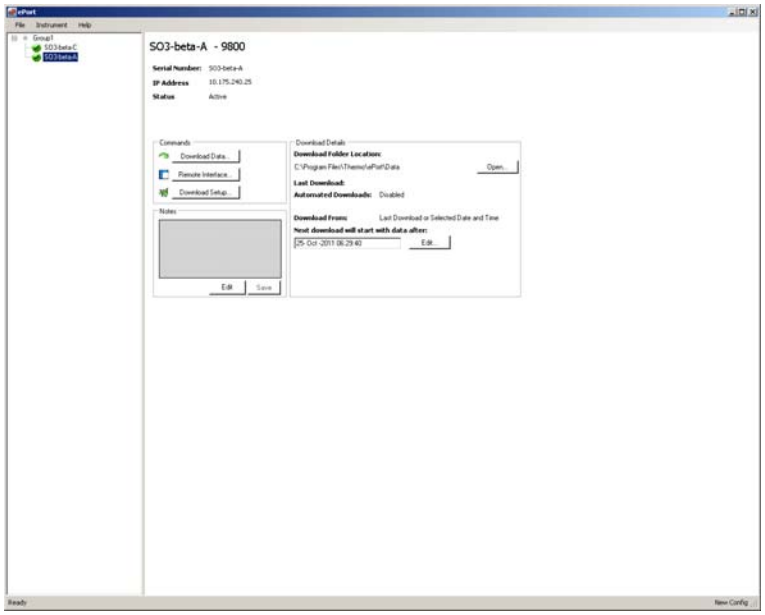


Figure B–17. ePort Main Screen

3. On the left side of the screen, click on the instrument you wish to download information from.

4. Select **Download Data** in the Commands window of the ePort Main screen. The Download Data screen will display (Figure B–18).

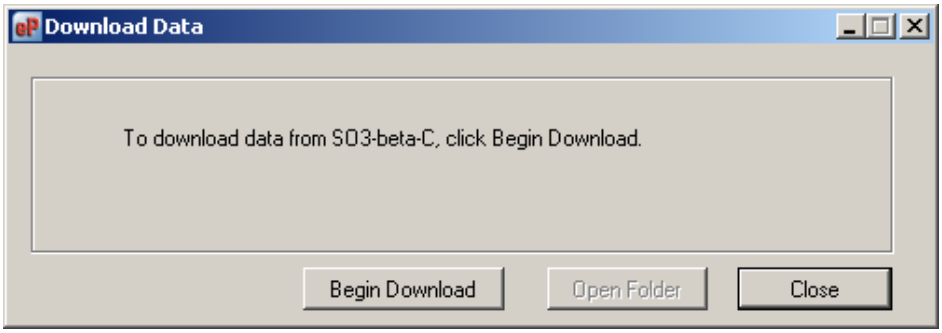


Figure B–18. Download Data Screen

5. Select the Begin Download button. The ePort software will download data based on the settings created in the Download Setup wizard. (Refer to the previous section for information on setting up downloads.) The message window will display a "Downloading Data" message while the software is downloading data from the instrument. When the download is complete, it will display a "Download Complete" message. Select the Done button to exit the Download Data screen.

Downloading Data to a Flash Drive

The SO_3 instrument also supports data downloads using the USB connection on the front of the instrument and a USB flash drive.

Note Depending on the size of the storage buffer, downloading all stored data could take up to 30 minutes or more. ▲

Use the following procedure to download data using the USB connection:

1. Plug a flash drive into the USB connection on the front of the instrument. The Download Data to USB Flash Drive screen will display (Figure B–19).

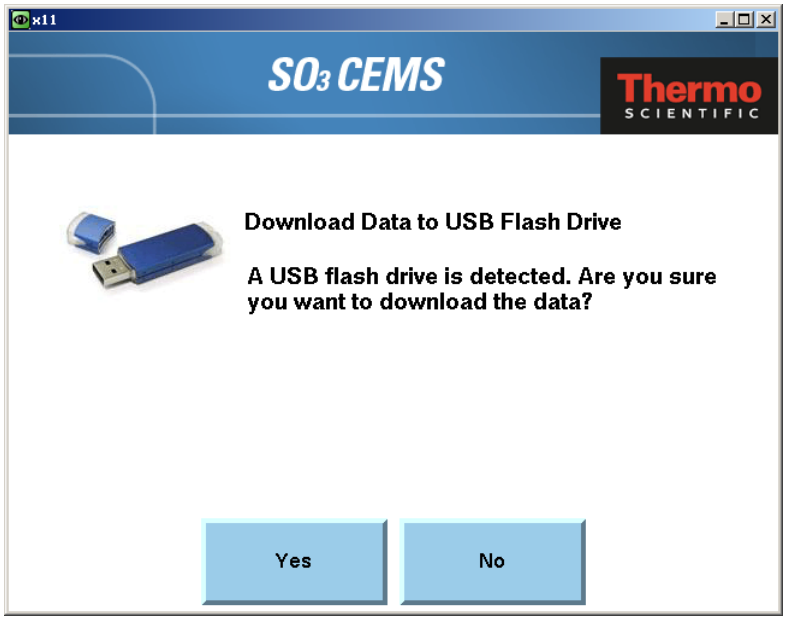

x11
SO3 CEMS
Thermo SCIENTIFIC
Download Data to USB Flash Drive
A USB flash drive is detected. Are you sure you want to download the data?
Yes
No

Figure B–19. Download Data to USB Flash Drive Screen

2. To continue with the download, select the Yes button. To cancel select the No button, then remove the USB drive.

3. The Select Data screen will display (Figure B–20). Select the **From the beginning** button to download all the data on the instrument. Select the **From last download** button to download only the data stored since the last data download. Select the **OK** button.

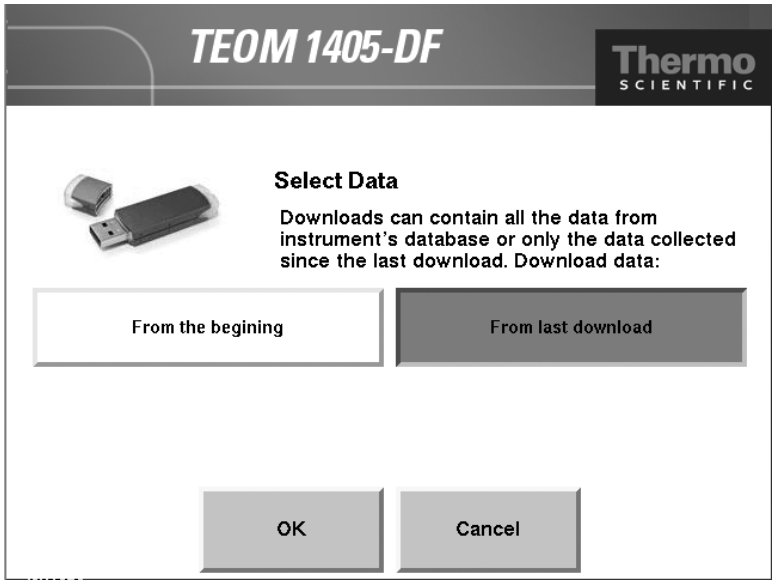

TEOM 1405-DF
Thermo SCIENTIFIC
Select Data
Downloads can contain all the data from instrument's database or only the data collected since the last download. Download data:
From the begining
From last download
OK
Cancel

Figure B–20. Select Data Screen

4. The instrument will display a “downloading data” message and begin transferring data to the USB drive.

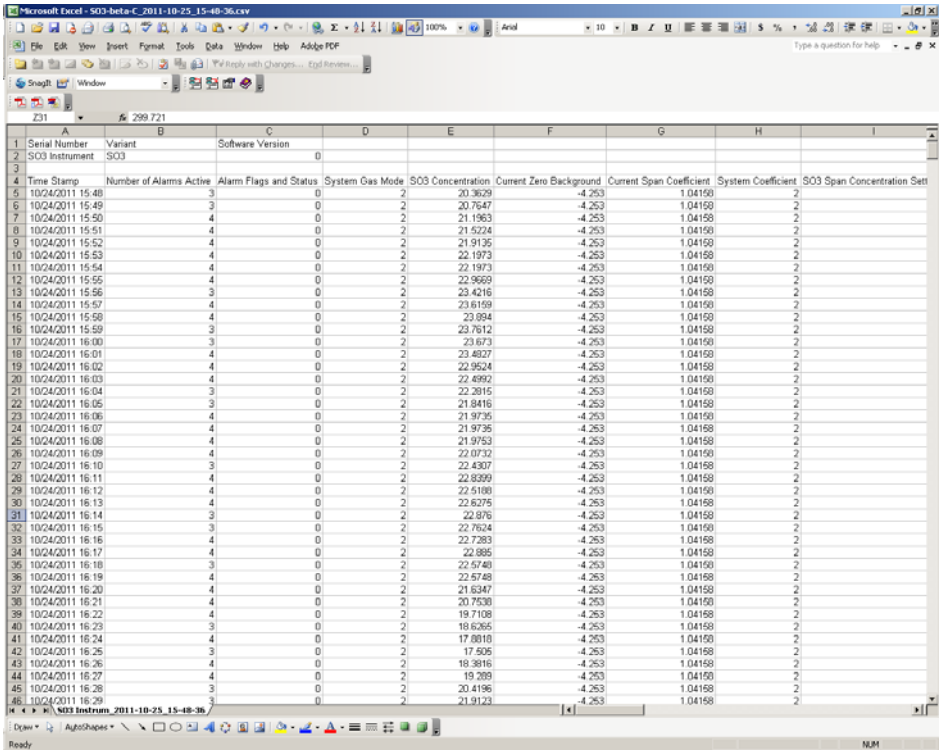
Note Do not remove the USB drive from the instrument while the data is downloading. ▲

5. When the data download is complete, the instrument will display a “Download complete” message and display the file name as it is stored on the USB flash drive. (The file name format is the instrument serial number followed by a date/time stamp.) Remove the USB flash drive and select the OK button to continue.

Viewing Downloaded Data

Data files are downloaded and saved as “.csv” files (.txt files through USB) that can be opened and viewed with Microsoft Excel. The file name format is the instrument serial number followed by a date/time stamp.

The data files will be saved to the folder selected using the Download Setup Wizard. Refer to the Setting Up for a Data Download section for information on setting up a data folder. The default folder location is: **C:\Program Files\Thermo\ePort\Data**



	A	B	C	D	E	F	G	H	I
1	Serial Number	Variant	Software Version						
2	SO3 Instrument	SO3	0						
3									
4	Time Stamp	Number of Alarms Active	Alarm Flags and Status	System Gas Mode	SO3 Concentration	Current Zero Background	Current Span Coefficient	System Coefficient	SO3 Span Concentration Sett
5	10/24/2011 15:48	3	0	2	20.3629	-4.253	1.04158	2	
6	10/24/2011 15:49	3	0	2	20.7647	-4.253	1.04158	2	
7	10/24/2011 15:50	4	0	2	21.1963	-4.253	1.04158	2	
8	10/24/2011 15:51	4	0	2	21.5224	-4.253	1.04158	2	
9	10/24/2011 15:52	4	0	2	21.9135	-4.253	1.04158	2	
10	10/24/2011 15:53	4	0	2	22.1973	-4.253	1.04158	2	
11	10/24/2011 15:54	4	0	2	22.1973	-4.253	1.04158	2	
12	10/24/2011 15:55	4	0	2	22.9669	-4.253	1.04158	2	
13	10/24/2011 15:56	3	0	2	23.4216	-4.253	1.04158	2	
14	10/24/2011 15:57	4	0	2	23.6159	-4.253	1.04158	2	
15	10/24/2011 15:58	4	0	2	23.894	-4.253	1.04158	2	
16	10/24/2011 15:59	3	0	2	23.7612	-4.253	1.04158	2	
17	10/24/2011 16:00	3	0	2	23.673	-4.253	1.04158	2	
18	10/24/2011 16:01	4	0	2	23.4827	-4.253	1.04158	2	
19	10/24/2011 16:02	4	0	2	22.9524	-4.253	1.04158	2	
20	10/24/2011 16:03	4	0	2	22.4992	-4.253	1.04158	2	
21	10/24/2011 16:04	3	0	2	22.2815	-4.253	1.04158	2	
22	10/24/2011 16:05	3	0	2	21.8416	-4.253	1.04158	2	
23	10/24/2011 16:06	4	0	2	21.9735	-4.253	1.04158	2	
24	10/24/2011 16:07	4	0	2	21.9735	-4.253	1.04158	2	
25	10/24/2011 16:08	4	0	2	21.9753	-4.253	1.04158	2	
26	10/24/2011 16:09	4	0	2	22.0732	-4.253	1.04158	2	
27	10/24/2011 16:10	3	0	2	22.4307	-4.253	1.04158	2	
28	10/24/2011 16:11	4	0	2	22.8399	-4.253	1.04158	2	
29	10/24/2011 16:12	4	0	2	22.5188	-4.253	1.04158	2	
30	10/24/2011 16:13	4	0	2	22.6276	-4.253	1.04158	2	
31	10/24/2011 16:14	3	0	2	22.876	-4.253	1.04158	2	
32	10/24/2011 16:15	3	0	2	22.7624	-4.253	1.04158	2	
33	10/24/2011 16:16	4	0	2	22.7283	-4.253	1.04158	2	
34	10/24/2011 16:17	4	0	2	22.885	-4.253	1.04158	2	
35	10/24/2011 16:18	3	0	2	22.5748	-4.253	1.04158	2	
36	10/24/2011 16:19	4	0	2	22.5748	-4.253	1.04158	2	
37	10/24/2011 16:20	4	0	2	21.6347	-4.253	1.04158	2	
38	10/24/2011 16:21	4	0	2	20.7538	-4.253	1.04158	2	
39	10/24/2011 16:22	4	0	2	19.7108	-4.253	1.04158	2	
40	10/24/2011 16:23	3	0	2	18.6265	-4.253	1.04158	2	
41	10/24/2011 16:24	4	0	2	17.8818	-4.253	1.04158	2	
42	10/24/2011 16:25	3	0	2	17.505	-4.253	1.04158	2	
43	10/24/2011 16:26	4	0	2	18.3816	-4.253	1.04158	2	
44	10/24/2011 16:27	4	0	2	19.289	-4.253	1.04158	2	
45	10/24/2011 16:28	3	0	2	20.4196	-4.253	1.04158	2	
46	10/24/2011 16:29	3	0	2	21.9123	-4.253	1.04158	2	

Figure B–21. Data .csv File Opened in Excel

Appendix C
Serial Communication

The Arke SO_3 System supports AK Protocol. This protocol permits a locally or remotely located computer to obtain information electronically from the unit. These protocols are described in this appendix.

AK Protocol

The AK Protocol allows the user to query the present value of any system variable remotely, and allows the user to change those system variable values. The user can also download information from the internal data logger. The RPComm software program uses this protocol for two-way communication directly to a personal computer or through a modem.

The following AK Protocol commands are presented in detail on the following pages:

- **AREG (Ask Register Command).** The use can query the analyzer for the current value of any system variable.
- **EREG (Enter Register Command).** The user can assign a new value to any system variable. Great care must be taken when using this command, as the value of variables should only be changed when the monitor is in the appropriate operating mode.
- **SFxx (Set Function xx Command).** The user can send commands using the <RUN> key and the <DATA STOP>key to the instrument. Each command is designated by a two-digit code, xx.
- **ASTO (Ask Storage Command).** The user can download a specified number of records from the internal data logger from the current position of the data storage pointer. The location of this storage pointer may be defined by the SSTO command. The values on each line of output are delimited by commas.
- **SSTO (Set Storage Command).** The user can change the location of the data storage pointer in the internal data logger, and is used in conjunction with the ASTO command described above. The data storage pointer is always located immediately after the last record transmitted through the RS232 port via the AK Protocol. If the circular buffer overwrites this location or if the ASTO or SSTO commands have not been used, the data storage pointer is positioned at the oldest record in the internal data logger.

For AK communication, the COM port settings are:

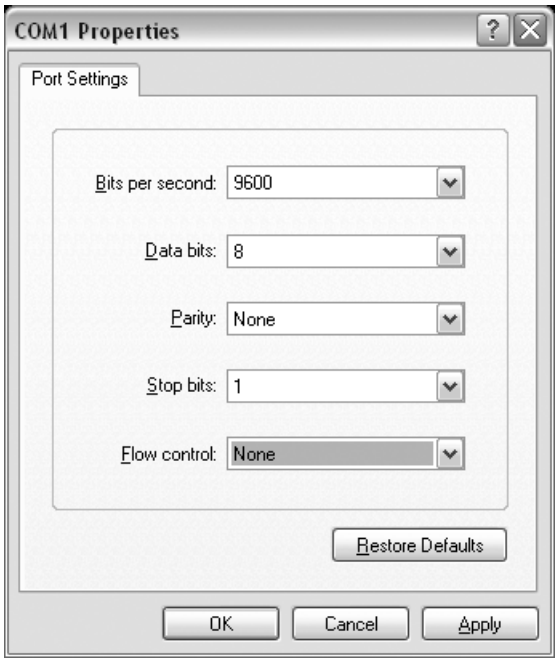


Figure C–1. AK COM Port Settings

The following pages list the common PRC codes and show how RS-Para 1 through RS-Para 4 are defined in the AK Protocol, and also detail the format of the transmission and response messages of the commands listed on the previous page.

Table C–1. Main PRC Codes

PRC Code	Description
001	SerialNumber
002	FirmwareVersion
003	InstrumentName
004	InstrumentType
005	Placeholder2
006	Placeholder3
007	Placeholder4
008	Placeholder5
009	Placeholder6
010	Placeholder7
011	Placeholder8
012	Placeholder9
013	Placeholder10

PRC Code	Description
14	Placeholder11
015	Placeholder12
016	Placeholder13
017	Command
018	DatabasePointer
019	Placeholder1
020	OperatingMode
021	StatusCondition
022	AlarmsActive
023	ProtectionLevel
024	Password
025	RegLogInterval
026	DisplayColor
027	DatabaseStatus
028	DataLogSuspend
029	SystemWaitTime
030	GUIStarted
031	InstrumentTime
032	HostName
033	NetworkProtocolStatic
034	StaticIPAddress
035	StaticSubnetMask
036	Gateway
037	AKStationCode
038	AKChannelNumber
039	AKSetTime
040	SerialMode
041	SerialCommunicationProtocol
042	SerialInstrumentID
043	SerialBaudRate
044	SerialDataBits
045	SerialParity
046	SerialStopBits
047	USBDetected

PRC Code	Description
048	USBMounted
049	USBSpaceCheck
050	USBDownloadDone
051	USBDownloadType
052	CPUBoardSerialNumber
053	CPUBoardStatus
054	CPUBoardFirmware
055	CPUBoardLoadStatus
056	CPUBoardSoftwareBuildNumber
057	CPUBoardSoftwareBuildDateTime
058	MotherBoardSerialNumber
059	MotherBoardStatus
060	MotherBoardFirmware
061	MotherBoardLoadStatus
062	MotherBoardVoltage3p3
063	MotherBoardVoltage5
064	MotherBoardVoltage5VSB
065	MotherBoardVoltage12V1
066	MotherBoardVoltage12V2
067	MotherBoardVoltage3p3Negative
068	MotherBoardVoltage12Negative
069	TimingControlBoardSerialNumber
070	TimingControlBoardStatus
071	TimingControlBoardFirmware
072	TimingControlBoardLoadStatus
073	TimingControlBoardVoltage3p3
074	TimingControlBoardVoltage5
075	TimingControlBoardVoltage12
076	TimingControlBoardVoltage
077	DetectorBoardSerialNumber
078	DetectorBoardStatus
079	DetectorBoardFirmware
080	DetectorBoardLoadStatus
081	DetectorVoltage3p3

PRC Code	Description
082	DetectorVoltage5
083	DetectorVoltageAnalogPlus
084	DetectorVoltageAnalogNegative
085	DetectorVoltage2p5
086	DetectorTempVoltageCTLI
087	DetectorTempVoltageITEC
088	DetectorTempPower
089	SystemControlBoardSerialNumber
090	SystemControlBoardStatus
091	SystemControlBoardFirmware
092	SystemControlBoardLoadStatus
093	SystemControlVoltage3p3
094	SystemControlVoltage5
095	SystemControlVoltage15
096	SystemControlVoltage15Negative
097	SystemControlVoltage12
098	LaserTempControlBoardSerialNumber
099	LaserTempControlBoardStatus
100	LaserTempControlBoardFirmware
101	LaserTempControlBoardLoadStatus
102	LaserHousingTempBoardSerialNumber
103	LaserHousingTempBoardStatus
104	LaserHousingTempBoardFirmware
105	LaserHousingTempBoardLoadStatus
106	StatusMotherboard
107	StatusProbeController
108	StatusInstrumentBoard
109	StatusLaserBoard
110	StatusDetectorBoard
111	SystemGasMode
112	SO3Concentration
113	SO3ConcentrationRaw
114	SO3ConcentrationRawAveraged
115	SO3ConcentrationAlarmHigh

PRC Code	Description
116	SO3ConcentrationAlarmLow
117	SO3SpanConcentration
118	DilutionRatio
119	PreviousDilutionRatio
120	SO3SpanConcentrationRead
121	SO3SpanConcentrationReadRaw
122	SO3SpanConcentrationReadAlarmHigh
123	SO3SpanConcentrationReadAlarmLow
124	LastCalibrationTime
125	CurrentZeroBackground
126	CurrentSpanCoefficient
127	PreviousCalibrationTime
128	PreviousZeroBackground
129	PreviousSpanCoefficient
130	ZeroDrift
131	SpanDrift
132	CalibrationError
133	CylinderConcentration
134	BenchPressure
135	BenchPressureRaw
136	BenchPressureAlarmHigh
137	BenchPressureAlarmLow
138	BenchPressureCalCoef
139	BenchPressureCalValue
140	BenchTemp
141	BenchTempRaw
142	BenchHeaterPowerControl
143	BenchTempSetpoint
144	BenchTempAlarmHigh
145	BenchTempAlarmLow
146	BenchTempCalCoef
147	BenchTempCalValue
148	ChassisTemp
149	ChassisTempRaw

PRC Code	Description
150	ChassisTempAlarmHigh
151	ChassisTempAlarmLow
152	ChassisTempCalCoef
153	ChassisTempCalValue
154	SO2MassFlowPowerControl
155	SO2MassFlow
156	SO2MassFlowRaw
157	SO2MassFlowSetpoint
158	SO2MassFlowAlarmHigh
159	SO2MassFlowAlarmLow
160	SO2MassFlowCalCoef
161	SO2MassFlowCalValue
162	SpanDilAirMassFlowPowerControl
163	SpanDilAirMassFlow
164	SpanDilAirMassFlowRaw
165	SpanDilAirMassFlowSetpoint
166	SpanDilAirMassFlowAlarmHigh
167	SpanDilAirMassFlowAlarmLow
168	SpanDilAirMassFlowCalCoef
169	SpanDilAirMassFlowCalValue
170	LaserPowerControl
171	LaserPowerStatus
172	LaserRamp
173	LaserPulse
174	LaserPulseClockFrequency
175	LaserDelay
176	LaserOffsetReferenceDAC
177	LaserRampReferenceDAC
178	LaserSpectFreq
179	LaserFrequencyLock
180	LaserVoltageSetpoint
181	LaserVoltageAlarmHigh
182	LaserVoltageAlarmLow
183	LaserTemp

PRC Code	Description
184	LaserTempRaw
185	LaserTempPowerControl
186	LaserTempPowerStatus
187	LaserTempSetpoint
188	LaserTempAlarmHigh
189	LaserTempAlarmLow
190	LaserTempCalCoef
191	LaserTempCalValue
192	LaserTempVoltage3p3
193	LaserTempVoltage1p5
194	LaserTempVoltage12VD
195	LaserTempVoltageCTLI
196	LaserTempVoltageITEC
197	LaserTempPower
198	LaserTempThermistorReferenceCoefA
199	LaserTempThermistorReferenceCoefB
200	LaserTempThermistorReferenceCoefC
201	LaserTempThermistorControlCoefA
202	LaserTempThermistorControlCoefB
203	LaserTempThermistorControlCoefC
204	LaserHousingTemp
205	LaserHousingTempRaw
206	LaserHousingPowerControl
207	LaserHousingPowerStatus
208	LaserHousingTempSetpoint
209	LaserHousingTempAlarmHigh
210	LaserHousingTempAlarmLow
211	LaserHousingTempCalCoef
212	LaserHousingTempCalValue
213	LaserHousingTempVoltage3p3
214	LaserHousingTempVoltage1p5
215	LaserHousingTempVoltage12VD
216	LaserHousingTempVoltageCTLI
217	LaserHousingTempVoltageITEC

PRC Code	Description
218	LaserHousingTempPower
219	LaserHousingThermistorReferenceCoefA
220	LaserHousingThermistorReferenceCoefB
221	LaserHousingThermistorReferenceCoefC
222	LaserHousingThermistorControlCoefA
223	LaserHousingThermistorControlCoefB
224	LaserHousingThermistorControlCoefC
225	DetectorAGCState
226	DetectorFrequency
227	DetectorDelay
228	DetectorInterval
229	DetectorOffset
230	DetectorMaxTecCurrentN
231	DetectorMaxTecCurrentP
232	DetectorMaxTecVoltage
233	DetectorTemp
234	DetectorTempRaw
235	DetectorTempPowerControl
236	DetectorTempSetpoint
237	DetectorTempAlarmHigh
238	DetectorTempAlarmLow
239	DetectorTempCalCoef
240	DetectorTempCalValue
241	DetectorPeakSignal
242	DetectorPeakSignalMinimaY
243	DetectorPeakSignalCal
244	DetectorPeakSignalAlarmHigh
245	DetectorPeakSignalAlarmLow
246	DataLoggingPeriod
247	DataLoggingTreatment
248	DataLoggingStart
249	DataloggingEndDateTime
250	DataloggingRecordsBack
251	StreamingPeriod

PRC Code	Description
252	StreamingTreatment
253	OtherPulserPulsesPerSec
254	OtherAveragingTime
255	OtherStartTime
256	OtherEndTime
257	RegLogIntervalDivisor
258	SpectrumBacklog
259	SpectrumSpikesLaserDataLength
260	SpectrumSpikesLaserData20Percent
261	SpectrumSpikesLaserVoltageRange
262	SpectrumSpikesTotal
263	TempAlarmsActive
264	SO3ConcentrationDataTemp
265	SO3ConcentrationDataNumber
266	SO3ConcentrationDataLog
267	SO3SpanConcentrationDataTemp
268	SO3SpanConcentrationDataNumber
269	SO3SpanConcentrationDataLog
270	SO3SpanConcentrationReadDataTemp
271	SO3SpanConcentrationReadDataNumber
272	SO3SpanConcentrationReadDataLog
273	SO2MassFlowDataTemp
274	SO2MassFlowDataNumber
275	SO2MassFlowDataLog
276	SpanDilAirMassFlowDataTemp
277	SpanDilAirMassFlowDataNumber
278	SpanDilAirMassFlowDataLog
279	BenchTempDataTemp
280	BenchTempDataNumber
281	BenchTempDataLog
282	BenchPressureDataTemp
283	BenchPressureDataNumber
284	BenchPressureDataLog
285	TimingControlBoardVoltageDataTemp

PRC Code	Description
286	TimingControlBoardVoltageDataNumber
287	TimingControlBoardVoltageDataLog
288	LaserTempDataTemp
289	LaserTempDataNumber
290	LaserTempDataLog
291	LaserHousingTempDataTemp
292	LaserHousingTempDataNumber
293	LaserHousingTempDataLog
294	DetectorTempDataTemp
295	DetectorTempDataNumber
296	DetectorTempDataLog
297	ChassisTempDataTemp
298	ChassisTempDataNumber
299	ChassisTempDataLog
300	ProbeTempDataTemp
301	ProbeTempDataNumber
302	ProbeTempDataLog
303	ProbeAmbientTempDataTemp
304	ProbeAmbientTempDataNumber
305	ProbeAmbientTempDataLog
306	StingerTempDataTemp
307	StingerTempDataNumber
308	StingerTempDataLog
309	SO3GeneratorTempDataTemp
310	SO3GeneratorTempDataNumber
311	SO3GeneratorTempDataLog
312	SO3GeneratorStitchTempDataTemp
313	SO3GeneratorStitchTempDataNumber
314	SO3GeneratorStitchTempDataLog
315	OrificeStitchTempDataTemp
316	OrificeStitchTempDataNumber
317	OrificeStitchTempDataLog
318	UmbilicalTempDataTemp
319	UmbilicalTempDataNumber

PRC Code	Description
320	UmbilicalTempDataLog
321	UmbilicalStitchTempDataTemp
322	UmbilicalStitchTempDataNumber
323	UmbilicalStitchTempDataLog
324	EductorPresDataTemp
325	EductorPresDataNumber
326	EductorPresDataLog
327	SampleDilutionAirPresDataTemp
328	SampleDilutionAirPresDataNumber
329	SampleDilutionAirPresDataLog
330	VenturiPresDataTemp
331	VenturiPresDataNumber
332	VenturiPresDataLog
333	SampleDilutionVacuumDataTemp
334	SampleDilutionVacuumDataNumber
335	SampleDilutionVacuumDataLog
336	SO3ConcentrationRawDataTemp
337	SO3ConcentrationRawDataNumber
338	SO3ConcentrationRawDataLog
339	DetectorPeakSignalMinimaYDataTemp
340	DetectorPeakSignalMinimaYDataNumber
341	DetectorPeakSignalMinimaYDataLog
342	AutoCalibrationState
343	AutoCalibrationPeriod
344	AutoCalibrationStart
345	AutoCalibrationZeroDuration
346	AutoCalibrationSpanDuration
347	AutoCalibrationTotalDuration
348	AutoCalibrationAverage
349	AutoCalibrationInhibited
350	AutoCalibrationCheckState
351	AutoCalibrationCheckPeriod
352	AutoCalibrationCheckStart
353	AutoCalibrationCheckZeroDuration

PRC Code	Description
354	AutoCalibrationCheckSpanDuration
355	AutoCalibrationCheckTotalDuration
356	AutoCalibrationCheckAverage
357	BlowbackScheduleState
358	BlowbackPeriod
359	BlowbackStart
360	BlowbackDuration
361	BlowbackPrevious
362	BakeSchedulePeriod
363	BakeScheduleStart
364	BakeScheduleDuration
365	BakeScheduleTemp
366	BakeSchedulePrevious
367	AnalogScalarsOutCal
368	AnalogScalarsOutCalDate
369	AnalogOutReg
370	AnalogOutReg
371	AnalogOutReg
372	AnalogOutReg
373	AnalogOutReg
374	AnalogOutReg
375	AnalogOutVoltage
376	AnalogOutVoltage
377	AnalogOutVoltage
378	AnalogOutVoltage
379	AnalogOutVoltage
380	AnalogOutVoltage
381	AnalogOutLowVoltageCalValue
382	AnalogOutLowVoltageCalValue
383	AnalogOutLowVoltageCalValue
384	AnalogOutLowVoltageCalValue
385	AnalogOutLowVoltageCalValue
386	AnalogOutLowVoltageCalValue
387	AnalogOutLowVoltageCalCounts

PRC Code	Description
388	AnalogOutLowVoltageCalCounts
389	AnalogOutLowVoltageCalCounts
390	AnalogOutLowVoltageCalCounts
391	AnalogOutLowVoltageCalCounts
392	AnalogOutLowVoltageCalCounts
393	AnalogOutHighVoltageCalValue
394	AnalogOutHighVoltageCalValue
395	AnalogOutHighVoltageCalValue
396	AnalogOutHighVoltageCalValue
397	AnalogOutHighVoltageCalValue
398	AnalogOutHighVoltageCalValue
399	AnalogOutHighVoltageCalCounts
400	AnalogOutHighVoltageCalCounts
401	AnalogOutHighVoltageCalCounts
402	AnalogOutHighVoltageCalCounts
403	AnalogOutHighVoltageCalCounts
404	AnalogOutHighVoltageCalCounts
405	AnalogOutVariable
406	AnalogOutVariable
407	AnalogOutVariable
408	AnalogOutVariable
409	AnalogOutVariable
410	AnalogOutVariable
411	AnalogOutRange
412	AnalogOutRange
413	AnalogOutRange
414	AnalogOutRange
415	AnalogOutRange
416	AnalogOutRange
417	AnalogOutMinValue
418	AnalogOutMinValue
419	AnalogOutMinValue
420	AnalogOutMinValue
421	AnalogOutMinValue

PRC Code	Description
422	AnalogOutMinValue
423	AnalogOutMaxValue
424	AnalogOutMaxValue
425	AnalogOutMaxValue
426	AnalogOutMaxValue
427	AnalogOutMaxValue
428	AnalogOutMaxValue
429	AnalogOutVoltageSlope0to100mV
430	AnalogOutVoltageSlope0to100mV
431	AnalogOutVoltageSlope0to100mV
432	AnalogOutVoltageSlope0to100mV
433	AnalogOutVoltageSlope0to100mV
434	AnalogOutVoltageSlope0to100mV
435	AnalogOutVoltageSlope0to1V
436	AnalogOutVoltageSlope0to1V
437	AnalogOutVoltageSlope0to1V
438	AnalogOutVoltageSlope0to1V
439	AnalogOutVoltageSlope0to1V
440	AnalogOutVoltageSlope0to1V
441	AnalogOutVoltageSlope0to10V
442	AnalogOutVoltageSlope0to10V
443	AnalogOutVoltageSlope0to10V
444	AnalogOutVoltageSlope0to10V
445	AnalogOutVoltageSlope0to10V
446	AnalogOutVoltageSlope0to10V
447	AnalogOutVoltageYIntercept0to100mV
448	AnalogOutVoltageYIntercept0to100mV
449	AnalogOutVoltageYIntercept0to100mV
450	AnalogOutVoltageYIntercept0to100mV
451	AnalogOutVoltageYIntercept0to100mV
452	AnalogOutVoltageYIntercept0to100mV
453	AnalogOutVoltageYIntercept0to1V
454	AnalogOutVoltageYIntercept0to1V
455	AnalogOutVoltageYIntercept0to1V

PRC Code	Description
456	AnalogOutVoltageYIntercept0to1V
457	AnalogOutVoltageYIntercept0to1V
458	AnalogOutVoltageYIntercept0to1V
459	AnalogOutVoltageYIntercept0to10V
460	AnalogOutVoltageYIntercept0to10V
461	AnalogOutVoltageYIntercept0to10V
462	AnalogOutVoltageYIntercept0to10V
463	AnalogOutVoltageYIntercept0to10V
464	AnalogOutVoltageYIntercept0to10V
465	AnalogOutCalibrateInitiate
466	AnalogOutCalibrateInitiate
467	AnalogOutCalibrateInitiate
468	AnalogOutCalibrateInitiate
469	AnalogOutCalibrateInitiate
470	AnalogOutCalibrateInitiate
471	AnalogInReg
472	AnalogInReg
473	AnalogInReg
474	AnalogInReg
475	AnalogInVoltage
476	AnalogInVoltage
477	AnalogInVoltage
478	AnalogInVoltage
479	AnalogInZeroCounts
480	AnalogInZeroCounts
481	AnalogInZeroCounts
482	AnalogInZeroCounts
483	AnalogInInputVoltage
484	AnalogInInputVoltage
485	AnalogInInputVoltage
486	AnalogInInputVoltage
487	AnalogInInputSpanCounts
488	AnalogInInputSpanCounts
489	AnalogInInputSpanCounts

PRC Code	Description
490	AnalogInInputSpanCounts
491	AnalogInDescription
492	AnalogInDescription
493	AnalogInDescription
494	AnalogInDescription
495	AnalogInReading
496	AnalogInReading
497	AnalogInReading
498	AnalogInReading
499	AnalogInUnit
500	AnalogInUnit
501	AnalogInUnit
502	AnalogInUnit
503	AnalogInPoint1CalValueInput
504	AnalogInPoint1CalValueInput
505	AnalogInPoint1CalValueInput
506	AnalogInPoint1CalValueInput
507	AnalogInPoint2CalValueInput
508	AnalogInPoint2CalValueInput
509	AnalogInPoint2CalValueInput
510	AnalogInPoint2CalValueInput
511	AnalogInPoint3CalValueInput
512	AnalogInPoint3CalValueInput
513	AnalogInPoint3CalValueInput
514	AnalogInPoint3CalValueInput
515	AnalogInPoint4CalValueInput
516	AnalogInPoint4CalValueInput
517	AnalogInPoint4CalValueInput
518	AnalogInPoint4CalValueInput
519	AnalogInPoint1UserValueInput
520	AnalogInPoint1UserValueInput
521	AnalogInPoint1UserValueInput
522	AnalogInPoint1UserValueInput
523	AnalogInPoint2UserValueInput

PRC Code	Description
524	AnalogInPoint2UserValueInput
525	AnalogInPoint2UserValueInput
526	AnalogInPoint2UserValueInput
527	AnalogInPoint3UserValueInput
528	AnalogInPoint3UserValueInput
529	AnalogInPoint3UserValueInput
530	AnalogInPoint3UserValueInput
531	AnalogInPoint4UserValueInput
532	AnalogInPoint4UserValueInput
533	AnalogInPoint4UserValueInput
534	AnalogInPoint4UserValueInput
535	AnalogInVoltagePoints
536	AnalogInVoltagePoints
537	AnalogInVoltagePoints
538	AnalogInVoltagePoints
539	AnalogInZeroInitiate
540	AnalogInZeroInitiate
541	AnalogInZeroInitiate
542	AnalogInZeroInitiate
543	AnalogInSpanInitiate
544	AnalogInSpanInitiate
545	AnalogInSpanInitiate
546	AnalogInSpanInitiate
547	AnalogInVoltageSlope
548	AnalogInVoltageSlope
549	AnalogInVoltageSlope
550	AnalogInVoltageSlope
551	AnalogInVoltageYIntercept
552	AnalogInVoltageYIntercept
553	AnalogInVoltageYIntercept
554	AnalogInVoltageYIntercept
555	AnalogInUserInitiate
556	AnalogInUserInitiate
557	AnalogInUserInitiate

PRC Code	Description
558	AnalogInUserInitiate
559	AnalogInUserCoef1
560	AnalogInUserCoef1
561	AnalogInUserCoef1
562	AnalogInUserCoef1
563	AnalogInUserCoef2
564	AnalogInUserCoef2
565	AnalogInUserCoef2
566	AnalogInUserCoef2
567	AnalogInUserCoef3
568	AnalogInUserCoef3
569	AnalogInUserCoef3
570	AnalogInUserCoef3
571	DigitalScalarsOutCal
572	DigitalScalarsOutCalDate
573	DigitalOutReg
574	DigitalOutReg
575	DigitalOutReg
576	DigitalOutReg
577	DigitalOutVariable
578	DigitalOutVariable
579	DigitalOutVariable
580	DigitalOutVariable
581	DigitalOutRelaySetting
582	DigitalOutRelaySetting
583	DigitalOutRelaySetting
584	DigitalOutRelaySetting
585	DigitalInReg
586	DigitalInReg
587	DigitalInReg
588	DigitalInReg
589	DigitalInReg
590	DigitalInReg
591	DigitalInReg

PRC Code	Description
592	DigitalInReg
593	DigitalInAction
594	DigitalInAction
595	DigitalInAction
596	DigitalInAction
597	DigitalInAction
598	DigitalInAction
599	DigitalInAction
600	DigitalInAction
601	DigitalInLogicState
602	DigitalInLogicState
603	DigitalInLogicState
604	DigitalInLogicState
605	DigitalInLogicState
606	DigitalInLogicState
607	DigitalInLogicState
608	DigitalInLogicState
609	GraphingDataXMin
610	GraphingDataXMax
611	GraphingDataVariable1
612	GraphingDataVariable2
613	GraphingDataVariable3
614	YAxis1
615	YAxis2
616	YAxis3
617	GraphingDataPrimaryYMax
618	GraphingDataPrimaryYMin
619	GraphingDataSecondaryYMax
620	GraphingDataSecondaryYMin
621	RawSpectrumYAxisMin
622	RawSpectrumYAxisMax
623	TransmissionSpectrumYAxisMin
624	TransmissionSpectrumYAxisMax
625	SO2ModeOn

PRC Code	Description
626	SO2SpanSetting
627	SO2SpikeCylinderConcentration
628	SO2SpikeMassFlowSetpoint
629	LaserVoltageSaved
630	SO2SpikeCalDilMassFlowSetpoint
631	ProbeSerialNumber
632	ProbeControllerFirmware
633	ProbeControllerFirmwareLoadStatus
634	ProbeControllerBlFirmware
635	ProbeControllerBlFirmwareLoadStatus
636	ProbeTemp
637	ProbeTempRaw
638	ProbeHeaterPowerControl
639	ProbeTempSetpoint
640	ProbeTempAlarmHigh
641	ProbeTempAlarmLow
642	ProbeTempCalCoef
643	ProbeTempCalValue
644	ProbeHysterisis
645	ProbeAmbientTemp
646	ProbeAmbientTempRaw
647	ProbeAmbientTempAlarmHigh
648	ProbeAmbientTempAlarmLow
649	ProbeAmbientTempCalCoef
650	ProbeAmbientTempCalValue
651	UmbilicalTemp
652	UmbilicalTempRaw
653	UmbilicalHeaterPowerControl
654	UmbilicalTempSetpoint
655	UmbilicalTempAlarmHigh
656	UmbilicalTempAlarmLow
657	UmbilicalTempCalCoef
658	UmbilicalTempCalValue
659	OrificeStitchTemp

PRC Code	Description
660	OrificeStitchTempRaw
661	OrificeStitchPowerControl
662	OrificeStitchTempSetpoint
663	OrificeStitchTempAlarmHigh
664	OrificeStitchTempAlarmLow
665	OrificeStitchTempCalCoef
666	OrificeStitchTempCalValue
667	UmbilicalStitchTemp
668	UmbilicalStitchTempRaw
669	UmbilicalStitchHeaterPowerControl
670	UmbilicalStitchTempSetpoint
671	UmbilicalStitchTempAlarmHigh
672	UmbilicalStitchTempAlarmLow
673	UmbilicalStitchTempCalCoef
674	UmbilicalStitchTempCalValue
675	StingerTemp
676	StingerTempRaw
677	StingerHeaterPowerControl
678	StingerTempSetpoint
679	StingerTempAlarmHigh
680	StingerTempAlarmLow
681	StingerTempCalCoef
682	StingerTempCalValue
683	SO3GeneratorTemp
684	SO3GeneratorTempRaw
685	SO3GeneratorHeaterPowerControl
686	SO3GeneratorTempSetpoint
687	SO3GeneratorTempAlarmHigh
688	SO3GeneratorTempAlarmLow
689	SO3GeneratorTempCalCoef
690	SO3GeneratorTempCalValue
691	SO3GeneratorConditioningState
692	SO3GeneratorStitchTemp
693	SO3GeneratorStitchTempRaw

PRC Code	Description
694	SO3GeneratorStitchHeaterPowerControl
695	SO3GeneratorStitchTempSetpoint
696	SO3GeneratorStitchTempAlarmHigh
697	SO3GeneratorStitchTempAlarmLow
698	SO3GeneratorStitchTempCalCoef
699	SO3GeneratorStitchTempCalValue
700	BlowbackPresPowerControl
701	SampleDilutionAirPres
702	SampleDilutionAirPresRaw
703	SampleDilutionAirPresPowerControl
704	SampleDilutionAirPresSetpoint
705	SampleDilutionAirPresAlarmHigh
706	SampleDilutionAirPresAlarmLow
707	SampleDilutionAirCalCoef
708	SampleDilutionAirCalValue
709	SampleDilutionVacuum
710	SampleDilutionVacuumRaw
711	SampleDilutionVacuumAlarmHigh
712	SampleDilutionVacuumAlarmLow
713	SampleDilutionVacuumCalCoef
714	EductorPres
715	EductorPresRaw
716	EductorPresPowerControl
717	EductorPresSetpoint
718	EductorPresCalSetpoint
719	EductorPresAlarmHigh
720	EductorPresAlarmLow
721	EductorCalCoef
722	EductorCalValue
723	VenturiPres
724	VenturiPresRaw
725	VenturiPresAlarmHigh
726	VenturiPresAlarmLow
727	VenturiCalCoef

PRC Code	Description
728	VenturiCalValue
729	AnalysisStartTime
730	AnalysisEndTime
731	AnalysisVariable1
732	AnalysisVariable2
733	ProbeAnalogOutSolenoidDriver
734	ProbeAnalogOutSwitch
720	EductorPresAlarmLow
721	EductorCalCoef
722	EductorCalValue
723	VenturiPres
724	VenturiPresRaw
725	VenturiPresAlarmHigh
726	VenturiPresAlarmLow
727	VenturiCalCoef
728	VenturiCalValue
729	AnalysisStartTime
730	AnalysisEndTime
731	AnalysisVariable1
732	AnalysisVariable2
733	ProbeAnalogOutSolenoidDriver
734	ProbeAnalogOutSwitch

Appendix D
Error Code Troubleshooting

The SO_3 Instrument maintains the status of the circuit boards in the system. In the event that one or more of the boards report a status of "FAIL" on the "System Status and Alarms > **Board Status**" screen, the following tables can be used to decode the details of the error.

This requires viewing the data logging table from the touch screen or offloading a data file from the instrument in order to obtain the error codes (see "Export to USB Flash Drive" and "Downloading Data to a Flash Drive" for details about offloading a data file from the instrument). Also, the corresponding Data Logging Variable must be selected (see "Data Analysis > Data Logging Settings > **Select Data Logging Variables**").

Use Table D–1 to configure the variable, identify the corresponding data file column name, and identify the board-specific table (below). Use the "Alarms Flag" (under Data Logging Variable Selection) as a top-level status indication. A non-zero valve indicates one or more of the boards contain an error status.

Table D–1. Board Summary Status

Board	Data Logging Variable Selection	Table
Instrument Status	Alarms Flags	Table D–2
Laser Temperature Control Board	Laser Temp Board Status	Table D–3
Laser Housing Temperature Control Board	Laser Housing Temp Board Status	Table D–4
Laser Timing Control Board	Laser Board Status	Table D–5
Laser Detector Board	Detector Board Status	Table D–6
System Control Board	System Control Board Status	Table D–7
Motherboard Status	Motherboard Status	Table D–8

Table D–2. Instrument Status

Status Code (in hexadecimal)	Description
0x00000000	no error
0x00000001	The CPU Board (module) has one or more error conditions.
0x00000002	The CPU Mother Board (baseboard) has one or error conditions.
0x00000004	The Laser Temperature Control Board has one or more error conditions.
0x00000008	The Laser Housing Temperature Control Board has one or more error conditions.
0x00000010	The Laser Timing Control Board has one or more error conditions.
0x00000020	The Laser Detector Board (MSP 0) has one or more error conditions.
0x00000040	The Laser Detector Board (MSP 1) has one or more error conditions.
0x00000080	The System Control Board has one or more error conditions.

Table D–3. Laser Temperature Control Board

Status Code (in hexadecimal)	Description
0x00000000	no error
0x00000000	There is a communications error with the board over the serial link.
0x00000000	The 3.3V supply is high.
0x00000000	The 3.3V supply is low.
0x00000000	The 1.5V supply is high.
0x00000000	The 1.5V supply is low.
0x00000000	The 12V supply is high.
0x00000000	The 12V supply is low.
0x00000000	The power draw on the 12V supply is too high.
0x00000000	The reference thermistor is disconnected.
0x00000000	The control thermistor is disconnected.
0x00000000	The board has shut off the TEC because the temperature is outside the safety shutdown bounds.

Table D–4. Laser Housing Temperature Control Board

Status Code (in hexadecimal)	Description
0x00000000	no error
0x00000001	There is a communications error with the board over the serial link.
0x00000002	The 3.3V supply is high.
0x00000004	The 3.3V supply is low.
0x00000008	The 1.5V supply is high.
0x00000010	The 1.5V supply is low.
0x00000020	The 12V supply is high.
0x00000040	The 12V supply is low.
0x00000080	The power draw on the 12V supply is too high.
0x00000100	The reference thermistor is disconnected.
0x00000200	The control thermistor is disconnected.
0x00000400	The board has shut off the TEC because the temperature is outside the safety shutdown bounds.

Table D–5. Laser Timing Control Board

Status Code (in hexadecimal)	Description
0x00000000	No error
0x00000001	There is a communications error with the board over the serial link.
0x00000002	The 3.3V supply is high.
0x00000004	The 3.3V supply is low.
0x00000008	The 5V supply is high.
0x00000010	The 5V supply is low.
0x00000020	The 12V supply is high.
0x00000040	The 12V supply is low.
0x00000080	A pulse clock error has been detected.

Table D–6. Detector Board

Status Code (in hexadecimal)	Description
0x00000000	No error
0x00000001	There is a communications error with the board over the serial link.
0x00000002	The 3.3V supply is high.
0x00000004	The 3.3V supply is low.
0x00000008	The 5V supply is high.
0x00000010	The 5V supply is low.
0x00000020	The 2.5V supply is high.
0x00000040	The 2.5V supply is low.
0x00000080	The +8V supply is high.
0x00000100	The +8V supply is low.
0x00000200	The -8V supply is high.
0x00000400	The -8V supply is low.

Table D–7. System Control Board

Status Code (in hexadecimal)	Description
0x00000000	No error
0x00000001	There is a communications error with the board over the serial link.
0x00000002	The +3.3V supply is high.
0x00000004	The +3.3V supply is low.
0x00000008	The +5V supply is high.
0x00000010	The +5V supply is low.
0x00000020	The +15V supply is high.
0x00000040	The +15V supply is low.
0x00000080	The -15V supply is high.
0x00000100	The -15V supply is low.
0x00000200	The +12V supply is high.
0x00000400	The +12V supply is low.
0x00000800	The stinger thermocouple is disconnected.
0x00001000	The probe thermocouple is disconnected.

Status Code (in hexadecimal)	Description
0x00002000	The SO_3 generator thermocouple is disconnected.
0x00004000	The umbilical thermocouple is disconnected.
0x00008000	The bench thermocouple is disconnected.
0x00010000	The SO_3 generator stitch thermocouple is disconnected.
0x00020000	The chassis temp thermistor is disconnected.
0x00040000	The probe ambient thermocouple is disconnected.
0x00080000	The 100ft umbilical thermocouple is disconnected.
0x00100000	The umbilical temperature control shutdown automatically due to limits being reached.
0x00200000	The bench temperature control shutdown automatically due to limits being reached.
0x00400000	The stinger temperature control shutdown automatically due to limits being reached.
0x00800000	The probe temperature control shutdown automatically due to limits being reached.
0x01000000	The generator temperature control shutdown automatically due to limits being reached.
0x02000000	The SO_3 generator stitch temperature control shutdown automatically due to limits being reached.
0x04000000	The 100ft umbilical temperature control shutdown automatically due to limits being reached.
0x08000000	The orifice stitch temperature control shutdown automatically due to limits being reached.
0x10000000	The orifice stitch thermocouple is disconnected.

Table D–8. Motherboard Status

Status Code (in hexadecimal)	Description
0x00000000	no error
TBD	TBD

Converting Decimal/Hexadecimal Numbers

Error codes in the data logging table are decimal (base 10) based numbers, which need to be converted to hexadecimal (base 16) numbers in order to defifer the board error. The easiest way to convert the decimal numbers reported by the unit is to use the calculator on a Windows-based PC.

To convert a decimal status code to a hexadecimal number:

1. Open the Windows calculator (From the Start menu, choose All Programs > **Accessories**.
2. Select View > **Scientific** to open the scientific-style calculator.
3. Select **Dec** to choose the decimal calculator option, and then enter the decimal status number into the calculator
4. Select **Hex** to choose the hexadecimal calculator option. The new number displayed in the calculator is the hexadecimal number you will use to decipher the status code list.

Note To convert a hexadecimal to a decimal number, select **Hex**, type in the hexadecimal number then select **Dec**. ▲

To properly use the hexadecimal numbers converted from the decimal data download, separate the converted number and the status codes on the table into place holders: the “one’s,” “ten’s,” “100’s,” “1,000’s,” “10,000’s,” and “100,000’s” and the “1,000,000’s” place. Each “place” in the converted code will have a hexadecimal digit. Each hexadecimal digit (0 -F) in each place will have a unique status code (or set of status codes) that go with it.

Table D–9. Hex Digits and Status Codes

Decimal Number	Hex Number	Code (sum of Codes)
0	0	0
1	1	H(1)
2	2	H(2)
3	3	H(1), H(2)
4	4	H(4)
5	5	H(1), H(4)
6	6	H(2), H(4)

Decimal Number	Hex Number	Code (sum of Codes)
7	7	H(1), H(2), H(4)
8	8	H(8)
9	9	H(1), H(8)
10	A	H(2), H(8)
11	B	H(1), H(2), H(8)
12	C	H(4), H(8)
13	D	H(1), H(4), H(8)
14	E	H(2), H(4), H(8)
15	F	H(1), H(2), H(4), H(8)

Deciphering Status Codes

When the unit shows more than one status code, it adds the codes together and displays them as a decimal sum. For example, if the unit displays a Memory status code (listed as hexadecimal number "(H)1" on the instrument's specific status code table) and a Valve A status code (listed as hexadecimal number "(H)4" on the instrument's specific status code table) at the same time, the two status codes (when downloaded) would be displayed as the decimal number "5."

The decimal number "5" must then be converted back to hexadecimal (in this case also "5") to match the status code table. Only two status codes would add up to a value of 5 (Table D–9). By looking at instrument's specific table and breaking down the downloaded status codes, you will be able to decipher which status codes the unit has displayed. Repeat the operation for each place in the hexadecimal code (10's, 100's, etc.).

Example

For example, decipher the following decimal status code (8433666) for an instrument with the given example status code table (Table D–10).

First convert the decimal status code downloaded from the monitor to a hexadecimal number using the Windows (or another scientific) calculator: 8433666= (H)80B002

Table D–10. Example Status Code Table

Code	Warning
&H1	Flash Memory
&H2	Power Switch (TPIC)
&H4	Valve A
&H8	Valve B
&H10	Filter A Temperature

Code	Warning
&H20	Filter B Temperature
&H40	Heater A Temperature
&H80	Heater B Temperature
&H800	External Sample Tube Temperature
&H1000	Serial Port Problem
&H2000	Line Printer Problem
&H4000	Leak on Loop A
&H8000	Leak on Loop B
&H10000	Audit Failure
&H20000	System Reset
&H40000	Power Failure
&H80000	Sample Volume Low
&H100000	Meter Out of Range (>09%)
&H400000	AC Voltage Out of Bounds
&H800000	Sensor Comm Problem
&H10000000	Pinch Valve

- In the “one’s” place of the status code, a status code of “2” is displayed. In the “one’s” place of the status code table, the “2” status code matches the (H)2 “Power Switch (TPIC)” status code. This is one of the status codes that the unit is displaying in its status code.
- In the “ten’s” place of the status code, there are no (0) status codes displayed.
- In the “100’s” place of the status code, there are no (0) status codes displayed.
- In the “1,000’s” place of the status code, a status code of “B” is displayed. Because there are no status codes in the status code table that match this number, the numbers needs to be broken down further. Convert “B” to a decimal number using Table A-2 — which converts B to “11.” Next, look at the status code table to decipher the status code. In the “1,000’s” place of the table, there are three status codes that, when added together, will total 11: (H)1000 “Serial Port Problem,” (H)2000 “Line Printer Problem” and (H)8000 “Leak on Loop B.” These are three more of the status codes that the unit is displaying in its status code.

- In the “10,000’s” place of the status code, there are no (0) status codes displayed.
- In the “100,000’s” place of the status code (800000), a status code of “800000” is displayed, which matches: (H)800000: “Sensor Comm Problem.”
- In the “1,000,000’s” place of the status code, there are no (0) status codes displayed.

Therefore, the downloaded status code “8433666” ((H)80B002) breaks down into the following status codes, according to the example status code table:

(H)2 “Power Switch (TPIC)”

(H)1000 “Serial Port Problem”

(H)2000 “Line Printer Problem”

(H)8000 “Leak on Loop B”

(H)800000 “Sensor Comm Problem”